DECEMBER 4, 1961

missiles and rockets

THE MISSILE/SPACE WEEKLY

OF MICHIGAN
DEC 3 1961
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Big BMEWS Dish—Part of Command/Control Network

DOD To Act on 'War Button' System . . .

$400 Million for Mercury Follow-on? . . . . .

North American Begins Work on Apollo . . 15

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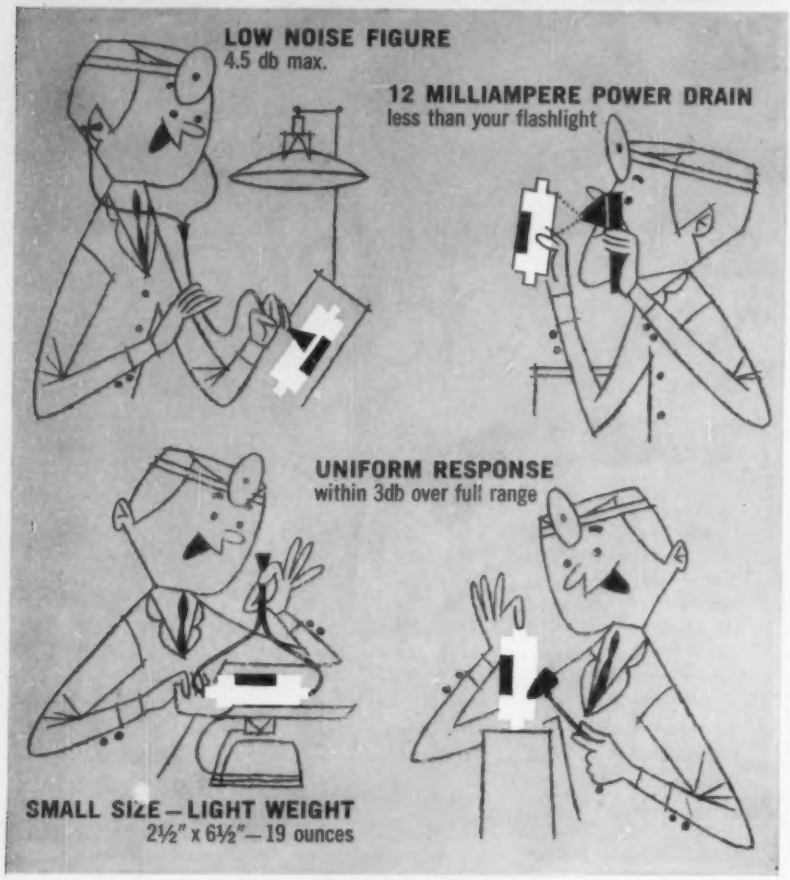

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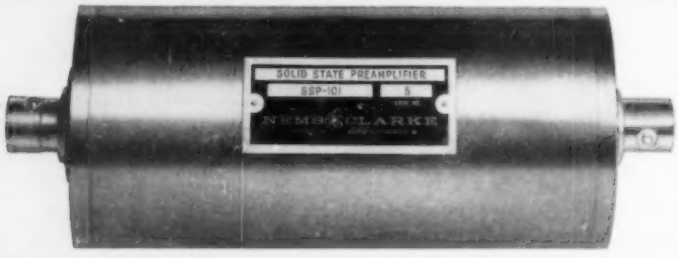

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—letters—

Dissecting Gilpatric

To The Editor:

Mr. James Baar's "dissection" of Deputy Defense Secretary Roswell L. Gilpatric's round-up of our defense posture ("Kennedy War Deterrent Remains Marginal," M/R, Oct. 30, p. 12), presents a few inaccuracies of its own.

Dissection of the dissection:

1. "The Russians have long been credited with a sufficient stockpile of IRBM's and MRBM's to wipe this entire force (our *Thors, Jupiters, Matadors, Maces,* fighter-bombers and medium bombers deployed around the Soviet periphery) from the board in a first strike."

This is a sweeping exaggeration of the operational capabilities of the Soviet missile command. Admittedly the *Thors* as presently sited, are sitting ducks; the *Jupiters* have better, but not ideal protection. *Maces* and *Matadors,* however, have some ground mobility; and of the fighter-bombers and medium bombers, under existing alert procedures, no Soviet planner could possibly be sure of catching even 50% on the ground in a surprise first strike.

The principle to be kept in mind is that of *deterrence,* and deterrence starts with *enemy* calculations of risk against advantage. What *might* happen if he had 100% good luck is of little importance. What counts is what he can reasonably expect to do, considered in terms of what certainly *will* happen to him if his expectations are not fulfilled. No coordinated missile strike of the magnitude required for this purpose has even taken place: the operational problems are enormous, quite aside from questions as to the reliability and accuracy of weapons. That Soviet planners could confidently count on more than a fractional success in such an effort is incredible.

2. "As for the attack carriers, there are five deployed in advance positions from which a retaliatory blow . . . could be mounted. However, whether the carriers in advance positions would survive the initial attack is debatable."

The overall number of operational attack carriers is being increased from 14 to 16. The total number deployed at any given time in the Mediterranean (6th fleet) plus the Western Pacific (7th fleet) may vary from five to seven. However, the 2nd Fleet in the North Atlantic is nearing the status of a deployed fleet. Since any coordinated first strike would require thorough advance planning and a selected strike-day, Soviet planners could not safely assume that at this preselected moment less than eight to ten carriers would be capable of prompt retaliation. Nor could they count, within limits of their capabilities, on destroying or damaging even one carrier *before her retaliatory strikes had taken off.*

3. "Only five (not six) *Polaris* submarines carrying a total of 80 missiles

(Continued on page 6)

THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 23 December 4, 1961

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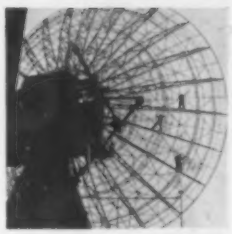

THE COVER

Huge antenna to be installed at last of three BMEWS stations, in England. BMEWS is key part of U.S. command/control system, which may be drastically reorganized. *See p. 12.*

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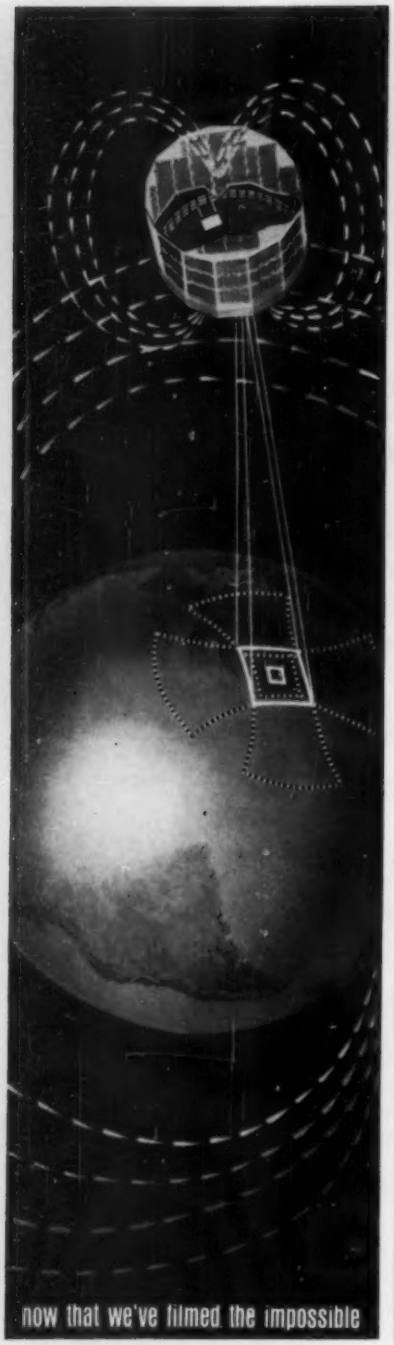

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Letters

(Continued from page 4)

have been deployed to date".

True, but this is nit-picking. The sixth submarine *(Ethan Allen)* is running her sea trials; three more of her class will be in commission early next year. Also, the *Polaris-B* missile with increased range will be coming into service.

Thus at least 500 fighter-bombers and medium bombers, three to five attack carriers and a substantial extra margin of *Polaris* capability must be added to Mr. Baar's estimate of the U.S. deterrent force which *the Soviet must assume* will survive a first strike.

As to the future, Soviet long-range planners must face the certainty of a steady increase in our *Polaris* fleet, to which they have developed (so far) no adequate countermeasures and will be even less able to do so as the range of the missile increases. I regret the decision not to continue B-52 production, which seems to me to be premature; but on balance I cannot agree with Mr. Baar that we are not making adequate provision to maintain a "clearly dominant military position" as far as our nuclear deterrent force is concerned. Continued superiority in that vital task must, in my view, depend chiefly on mobile rather than fixed-site weapons.

With Mr. Baar's contention that we are not doing enough "for the development of military offensive and defensive space systems"—as reflected in the guide lines for the Fiscal Year '63 budget—I certainly do agree. I wish he had made a more convincing argument on this point, and perhaps for more steam behind the antimissile program, for a comprehensive and urgent approach to antisubmarine warfare, and for manpower levels for all the services that would be reasonably adequate to meet our rising global responsibilities. It is in these areas—space included—that it seems to me Secretary Gilpatric glossed over our shortcomings, rather than in the nuclear deterrent field.

GEORGE FIELDING ELIOT
New York City

A Reply

Mr. Eliot, the eminent writer on military affairs, has raised some very important points.

A dissection of Mr. Eliot's dissection: He says,

1. "No Soviet military planner could possibly be sure of catching even 50% (of the Free World land-based strategic forces overseas) on the ground in a surprise attack."

On the other hand no U.S. military planner can be sure that the Russians would not be able to catch 80 to 90 per cent. *For some time, U.S. military planners have credited the Russians with having these forces outgunned. No one can be certain how effective a surprise attack on these forces would be. But, as Mr. Eliot correctly notes, deterrence "starts with enemy calculations"—what the enemy believes is credible. And missile experts generally estimate that Soviet confidence in the reliability of the Red Army's long-tested IRBM's and MRBM's is quite high.*

Moreover, Mr. Eliot did not mention the attrition factor. All of the Free World's land-based overseas forces except for the soft Thors and Jupiters are air-breathing and, therefore, even if they survived a surprise blow, they would have to run the Soviet air defenses. The carrier-based aircraft, of course, face the same tactical problem.

2. ". . . Soviet planners could not safely assume that . . . less than eight to 10 carriers would be capable of prompt retaliation."

Mr. Eliot is in error. The United States today has only five attack carriers in deployed positions from which a strategic nuclear air strike could be mounted promptly. With luck, this force would be as large as seven if replacement carriers were arriving or departing at the time of the attack. All other U.S. carriers would be several to many days away from striking distance.

Mr. Eliot correctly notes that Soviet planners could not count on knocking out the carriers in advance positions before retaliatory strikes were launched. Nor, as the article pointed out, can U.S. planners count on the carriers not being knocked out.

3. Mr. Eliot says that it is "nit-picking" to note that five—not six—Polaris submarines are deployed. In considering the overall alignment of forces, he is correct. But the fact that Gilpatric erroneously said that six were deployed fitted the "good news" pattern of his address and was pointed up in the article for this reason.

As for Mr. Eliot's statement that "three more (Polaris) submarines will be in commission early next year," this is incorrect if by "in commission" he means deployed. The first of the three more submarines that he is talking about will be deployed in the spring; the last in the fall.

This last point is raised because for a number of years there has been a great tendency among many people in and out of the government—particularly in the government—to equate future plans with forces-in-being. For example, many statements are heard about the first Minutemen ICBM's being operational in mid-1962. This is roughly correct if the accent is put on the word "first." Actually, the first squadron is not expected to be deployed before the end of the year.

Regarding the need for much greater work on military offensive and defensive space systems and the strategic importance of deploying an antimissile missile system, the article did not expand on these points because they have been extensively covered in previous M/R stories.

In general, the question as to whether the United States is "making adequate provisions to maintain a 'clearly dominant military position,'" must be decided on two points:

—How credible does the United States want to make its deterrent force? Put another way, how narrow or how wide are the American people willing to have the margin of safety?

—Will America continue to be satisfied

with a Cold War policy of trying to maintain a fine balance of nuclear terror in hopes that sooner or later Russia will "change?"

James Baar

Shortage of Help?

To The Editor:

As a charter subscriber to your fine magazine, I have noted in it—and in other sources—a continuous demand for a greater space effort on the part of the U.S.: that our effort should be increased by 50% or some other figure.

I am heartily in accord with all this, but I have wondered for a long time if the technical help is available—or rather, can be made available—to carry out this increased effort. Our industrial effort is now—and probably will continue to be in the foreseeable future—primarily devoted to putting out consumers' goods; even so, a large part of our technical help is already engaged in defense work. Also, there is the well-known problem of technical education.

One has only to scan page after page of professional employment ads in such publications as *The New York Times* and the *Los Angeles Times* to be greatly impressed with the number of highly trained and experienced men needed for the present effort. Where would the help come from for a greatly increased effort?

The writer has never read a really good report on this vital matter. Perhaps your magazine can publish one, written by your staff or by an outsider—an authoritative treatise by someone who really knows the facts.

EMERSON W. CASE
Fair Oaks, Calif.

Non-Profit Brainpicking

To the Editor:

Regarding your Oct. 16 editorial "Enough of This Non-Profiteering," one can but wonder as to the history of the individuals who are employees of these organizations at one time or another.

The realistic situation which worries industry is that the broad need-to-know granted such organizations (and only a few years ago to a group in Melpar which was studying for the Air Force), gives the *individuals* license to pick brains all across the board.

With this reservoir of proprietary and company-confidential data, plus a lot of know-how generated from seeing how many companies work, make good decisions, and also make mistakes, the individual automatically becomes quite valuable to private industry—whether as an employee or as a person starting his own company.

We may even grant that 95% of all workers for the non-profits intend to and even will, stay with those organizations—for life. It's the potential 5% (and my numbers are probably quite conservative) who come around, pick our brains, and put out two together with somebody else's two to get a four-plus for themselves, and possibly employment with some competitor.

It would be interesting to run an em-

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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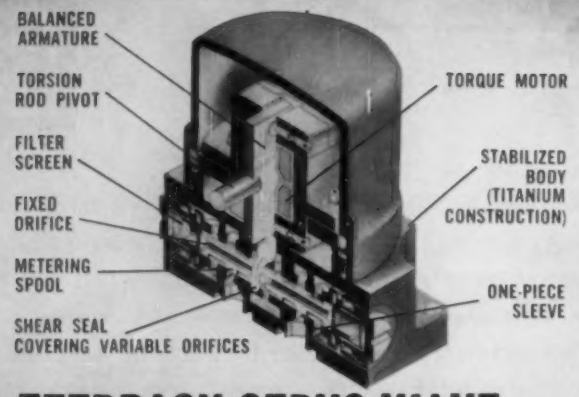

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ployment profile of some of the former STL, Aerospace, MITRE, JPL, IDA, etc., executives and scientists.

We are actually not against non-profits. We know we can't solve the brain-picking situation by doing away with them (for the civil servant, as an individual, has the same capability). However we do question the propriety or desirability of broadening the scope of these rather anamolous types of extragovernmental brain factories—which must necessarily take their raw material either from within Government or from private industry. It would be interesting to see how many former employees went back into private industry after a tour with the non-profits.

Charles Kelchner
Washington, D. C.

Further Afterthoughts

To the Editor:

A hearty congratulation for your thought-provoking Nov. 6 editorial ("Afterthoughts of a Saturnalia").

Any contribution like yours toward informing the public about the present deathly situation is doubly useful in times like ours when political expediency seems predominant.

P. L. Bargellini
Associate Professor
of Electrical Engineering
University of Pennsylvania
Philadelphia

To the Editor:

Congratulations on the editorial. Things *should* work.

General Bernard Schriever's statement, "Space power is peace power," could well be adopted as a national slogan. It takes space power to keep space for peaceful purposes.

With respect to the (implied) statement, "All is well—back to your fallout shelters," there are very few fallout shelters.

David W. Johnston
Washington, D. C.

Quite Right

To the Editor:

Your article on *Saturn* S-IB (M/R, Nov. 13, p. 17) refers to "Launch Complex-39 which will have two pads and will be completed in 1963."

I am sure you must mean Launch Complex-37, now under contract to be completed in 1963.

George Schlesinger
Ets-Hokin & Galvan, Inc.
San Diego, Calif.

Counterdust

To the Editor:

The "meteoroid hazard" (M/R, Nov. 6, p. 32) can be effectively met by maintaining loose material varying from over an inch in size down to a fine dust where it will be drawn over the puncture by the escaping air.

Theodore B. Dufur
Los Angeles

The Countdown

WASHINGTON

FCC-White House Joust over ComSat

A hot fight is under way between the FCC and other Administration officials over ownership of the planned commercial communications satellite system. If not resolved quickly, the battle is certain to spread to Congress. FCC officials, in opposition to White House plans, favor the establishment of a profit-making corporation to operate the commercial communications satellite net. The common carriers would own the stock.

Bomarc B Base No. 3

The third U.S. *Bomarc B* base is nearly ready to join NORAD. The base is at Niagara Falls, N.Y., Municipal Airport. Two other *Bomarc B* sites—Duluth, Minn., and Kincheloe AFB, Mich.—already are operational. In all, five are planned within the borders of the United States, two in Canada.

Saturn on the Canal

The ground-support debate in NASA over whether a canal-barge system or a rail transporter should be used in the *Saturn C-4* launching complex appears to have been settled. The winner: The canal-barge. The main reason: It is expected to be cheaper.

Navigation for A-3

Navy sources say that a new gyro appears to have assured development of the improved navigation system needed for the 2500-mile-range *Polaris A-3*. The gyro—the Mark 1 Mod 2 developed by Sperry—has already undergone trials aboard the nuclear-powered sub Ethan Allen. The additional range of the *A-3* considerably increases the need for accurate navigation of *Polaris* submarines.

Enterprise to Get Advanced Terriers

The huge nuclear-powered Enterprise has joined the fleet without any surface-to-air weapons, but she is scheduled to receive *Advanced Terriers*. One battery of the Convair missiles will be installed on her port quarter, one on her starboard. No date for the retrofitting has been set.

Titan I: In the Green When?

The first nine-missile squadron of *Titan I's* now is not officially expected to be declared operational until sometime in January. However, there is a chance that the first complex of three Martin *Titans* at Lowry AFB, Colo., may be declared operational this month to keep the slipping operational date for the first *Titan* within 1961.

NASA to Write Nova-5 Specs

The Golovin Committee is understood to have recommended that NASA be permitted to continue writing the specifications for the solid superbooster to be developed by the Air Force. The committee reached no decision on whether the motors of the solid booster should be 160 or 240 inches. A compromise is expected.

INDUSTRY

Ling-Temco the Winner—Apparently

Ling-Temco-Vought appears to have won its merger battle with the Justice Department. The government has failed in District Court to stop the uniting of Ling-Temco and Chance Vought, and the chances of a government appeal look slim.

R&D Intelligence

The $10-million award of an AEC contract to STL for development of a *Vela Hotel* satellite is seen as a small first step toward a much biger program . . . Appointment of Dr. James H. Gardner, VP of the National Research Corp., as Pentagon Deputy Director of R&E for engineering and chemistry is expected by some to give a new boost to chemical research. . . .

Instant Rebates

The Navy is planning to switch its policy on rebates due the Government under price-revision clauses in contracts. Formerly the Navy waited to collect until a final contract price was negotiated. A new directive will call for immediate refunds.

INTERNATIONAL

Missile/Space Consortium Established

A European industrial consortium is being established to develop missiles and jet aircraft for NATO. Among the principal firms involved are Hawker-Siddeley of Britain, Breguet of France, Focke-Wulf of Germany, Fokker of the Netherlands and Avions Fairey of Belgium. Republic is reported to be interested in joining.

Overseas Pipeline

SEREB has been successfully testing 7000-lb. *Agathe* rockets at the Hamaguir Range in the Sahara . . . The site for the BMEWS No. 3 Station at Fylingdales in Yorkshire is being reduced from 2400 to 900 acres . . . COSPAR has decided to hold its Third International Space Science Symposium in Washington next May.

Russian X-15?

Observers report seeing Russian turboprop Bear bombers carrying a swept-wing rocket plane under their fuselages. Reports say the rocket plane could be an air-breathing missile but appears more likely to be a Soviet version of the *X-15*.

The Missile/Space Week

Way Cleared for ComSat Operation by Profit-makers

The Kennedy Administration is expected to announce in the near future support for a private, profit-making corporation to run a commercial communication satellite system.

The recommendations will call for congressional action to enact them into law. This will take the decision on ownership of the satellite system out of the hands of the Federal Communications Commission, where it now lies.

Preparation of the Administration position was the work of the National Aeronautics and Space Council, which consulted with interested government agencies.

Informed sources report that the council's recommendations were ready for submission to President Kennedy last week.

They called for:

- A profit-making corporation to be set up with private—not public—ownership.
- Ownership of stock in the corporation would not be restricted to communication carriers. It was not clear whether the council's proposal would open ownership to private individuals or simply to foreign communication carriers and equipment manufacturers.
- Some form of government body would be set up to ride herd on the corporation to insure that all U.S. government interests were protected. This could take the form of one individual, the space council or a special committee.
- NASA would proceed with research and development of the system and would provide technology, launch vehicles, tracking network and possibly equipment to the corporation.

The Administration decision to put the final decision on ownership of the system up to Congress means that final action will be put off until next year. The ensuing congressional consideration might delay it until late in the year.

Submission of the ownership decision to Congress will probably also touch off a jurisdictional battle between various congressional committees. Logically, such legislation would be introduced in the commerce committees of both houses of congress.

Sen. Robert S. Kerr, (D-Okla.), Chairman of the Senate Space Committee, muddied the picture when he announced that he would introduce legislation on the subject. Sen. Russell Long (D-La.), chairman of the Senate Small Business Anti-monopoly Subcommittee, is also reported to be preparing legislation.

All of the Administration and congressional action means that the proposal by U.S. communication carriers for a non-profit corporation to run the system is dead.

Shots of the Week

A chimpanzee circled the earth twice in a *Mercury* capsule on Nov. 29 and was recovered successfully. Technical problems prompted NASA to bring down the capsule after two, rather than the planned three orbits (see story on p. 14).

In military launchings:

- A Strategic Air Command crew fired an *Atlas* from a semi-hard launch pad at Vandenberg AFB, Calif., Nov. 29 in a combat readiness test. The crew was from the 576th Strategic Missile Squadron.
- A *Titan*, first to be launched by a "blue suit" crew from Air Force's Aerospace Test Wing, was fired Nov. 21 down the Atlantic Missile Range. The ICBM carried a warhead designed by General Electric for the *Nike-Zeus* AICBM tests coming up in the Pacific next year.
- The Air Force launched an *Atlas-Agena B* carrying either a *Samos* or *Midas* satellite from Point Arguello on Nov. 22. Details of the firing were kept secret.
- Test firings of *Asp-Apache* research rockets from Roi-Namur island off Kwajalein in the Pacific began Nov. 15, the Army disclosed. They are part of the *Highball* series used in connection with the *Zeus* test program (M/R, Jan. 30, p. 44).

MacBride Quits G-D

C. Rhoades MacBride has resigned as executive vice president of General Dynamics Corp. He had headed the five western aircraft/missile divisions which were created in a company reorganization earlier this year. R. C. Loomis, president of General Dynamics/Convair, which has operated the troubled 990 jet transport program, also is leaving the company.

Reds Block Cooperation Plan

Soviet insistence that the UN's Committee on Peaceful Uses of Outer Space favors the Western military bloc has thrown a damper on the new U.S. plan for a joint weather and communications space net.

The Russians ended their long boycott of the committee last Monday, but delegate Zorin reaffirmed the Soviet position favoring committee reorganization on the basis of equal representation for Western, Communist, and neutralist nations. He also said that nothing could be accomplished in this area without U.S.-Russian agreement.

AIA Blasts Exhibitionism

The Aerospace Industries Association moved last week to crack down on costly defense products displays at technical meetings and conventions.

A resolution criticized "the multiplicity of exhibitions, and unnecessary diversion of effort, money, and attention from the more important endeavors in which members are engaged." The statements were directed at both industry and sponsoring societies.

Kimball to Head AIA Board

Dan A. Kimball, president of Aerojet-General Corp., has been elected chairman of the board of governors of the Aerospace Industries Association for 1962.

William M. Allen, president of The Boeing Co., was named vice chairman, and August C. Esenwein was elected president. Esenwein replaces Orval R. Cook, who retires Dec. 31.

Also elected to the executive committee of the board were: Donald W. Douglas, Jr., president, Douglas Aircraft Co., Inc.; H. M. Horner, chairman, United Aircraft Co.; and Carl G. Holschuh, executive vice president, Sperry Rand Corp.

George F. Hannaum was elected vice president; and Samuel L. Wright, secretary-treasurer.

Other members of the board are company presidents: J. R. Kerr, Avco Corp.; O. A. Beech, Beech Aircraft Corp.; Malcolm P. Ferguson, The Bendix Corp.; William M. Allen, The Boeing Co.; Donald W. Douglas, Douglas Aircraft Co.; Earl D. Johnson, General Dynamics Corp.; E. Clinton Towl, Grumman Aircraft Engineering Corp.; A. G. Handschumacher, Lear Inc.; William S. Bergen, Martin Co., a division of Martin Marietta Corp.; J. S. McDonnell, McDonnell Aircraft Corp.; Thomas V. Jones, The Northrop Corp.; Mundy I. Peale, Republic Aviation Corp.; and J. W. Crosby, Thiokol Chemical Corp.;

Also, G. J. Lynch, vice president and general manager, Aeronutronic Division of Ford Motor Co.; J. C. Garrett, chairman, The Garrett Corp.; Jack S. Parker, executive vice president, General Electric Co.; H. H. Dice, general manager, Allison Division of General Motors Corp.; L. A. Hyland, vice president, Hughes Aircraft Co.; Courtlandt S. Gross, chairman, Lockheed Aircraft Corp.; J. H. Kindelberger, chairman, North American Aviation, Inc.; A. L. Malcarney, executive vice president, Defense Electronic Products, RCA; J. D. Wright, chairman, Thompson Ramo Wooldridge Inc.; H. M. Horner, chairman, United Aircraft Corp.; and Albert Boyd, vice president, Defense Products, Westinghouse Electric Corp.

Captive Dipoles Spotted?

Despite a fourth radar sighting of what is probably the Project *Westford* needle package, Lincoln Laboratory holds out little hope that the copper dipole payload orbited Oct. 21 will ever be released.

Radar returns from an object of about the right size and orbit were announced on Nov. 3, 13, 15 and 22, but signal strength is too weak for positive identification.

Detection of the 2000-mile-high object has been made by the 2-degree beamwidth Millstone Hill antenna in Westford, Mass. Continuing search with this antenna may refine orbital information to allow detection with the .15-deg. beam Project *Westford* antenna, on the same frequency as the copper needles.

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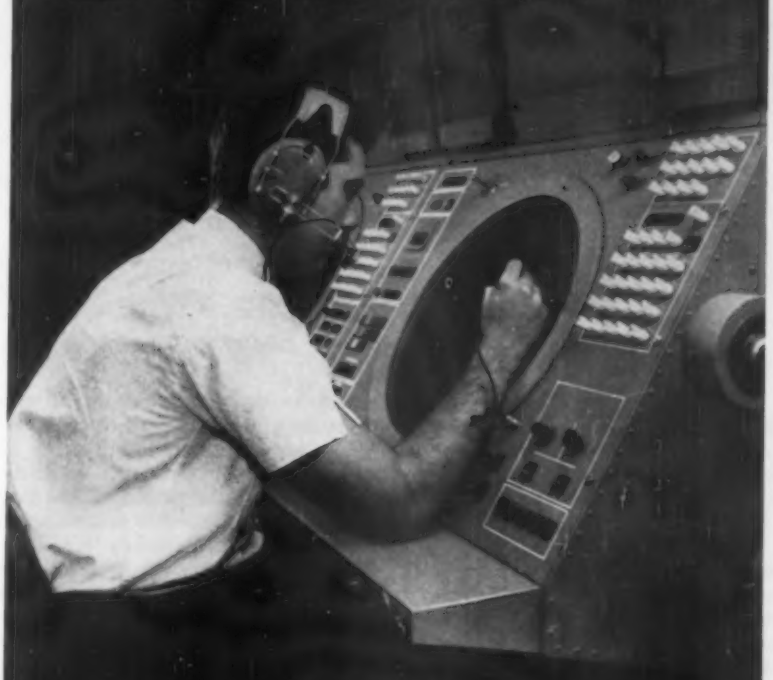

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Command and Control Systems: Air Defense, Space Vehicles, Air Traffic

by James Baar

New U.S. Command System Coming

DOD expected to tap Air Force-Mitre team for R&D of sweeping revision in nation's 'war button' network

THE PENTAGON is nearing a top-level decision on initiating development of a new National Command and Control System to enable the United States to fight any kind of war in the Missile/Space Age.

Such a vast electronic system would be designed so that the United States could command and control all its forces in a deliberate, swift and flexible manner—regardless of the type of attacks the nation might undergo.

In effect, today's vulnerable, all-but one-shot nuclear war button in the White House would be converted into a series of highly survivable buttons that could be used in a variety of ways over an extended period of time.

A secret report on U.S. needs for development of a closely-integrated, electronic National Command and Control System of this type is now before Defense Secretary Robert S. McNamara. The report is the result of some two months of study by a McNamara-appointed task force headed by Gen. Earle E. Partridge (ret.), former commander of NORAD.

The Partridge Study is reported to call for a new National Command System in conjunction with reorganization of the command structure. The reorganization is reported to include the creating of a Supreme U.S. Military Commander over nearly all combat forces —an extremely controversial proposal opposed by many congressmen.

McNamara must decide whether work on development of the National System should begin immediately, who would have overall charge of the program and who would direct the development work.

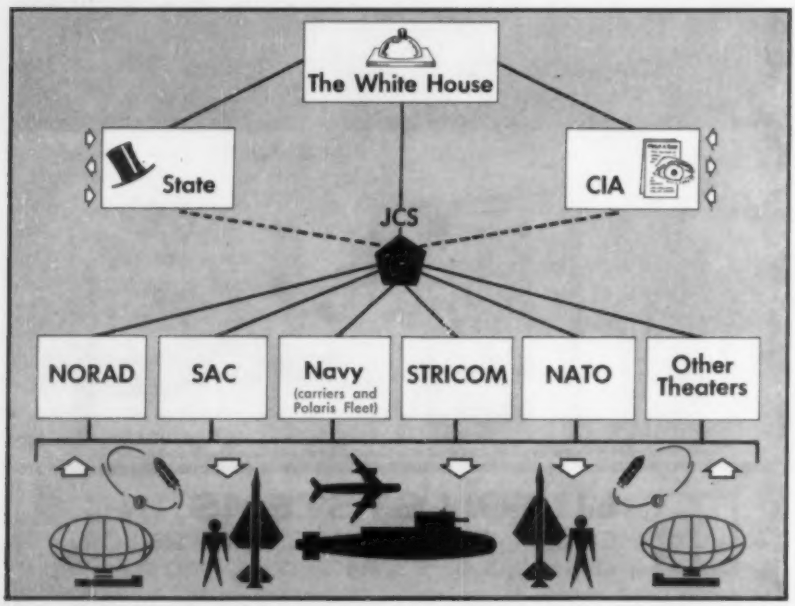
• **Logical choice?**—The Air Force Electronic Systems Division (ESD) at L. G. Hanscom Field, Mass., and its technical associate, the non-profit Mitre Corp., are considered by many experts in the field as the logical choice for the big development assignment for the Defense Department. This conclusion is based on their broad past and current experience.

However, some parts of the program are expected to be assigned to other groups and agencies where some of the highly-specialized capabilities needed now exist.

ESD, with the strong support of Mitre in varying degrees, is directing the development and construction of 14 Air Force command and control systems of different types—the famed "L" systems. Moreover, ESD and Mitre are planning the integration of all of these and future Air Force command and control systems into one worldwide Aerospace Command and Control System.

These operations already involve a total Air Force outlay of about $1 billion a year.

The National System would carry the integration process one large step higher to the pinnacle of the U.S. com-



COMMAND AND CONTROL SYSTEM must integrate partly independent systems.

STATION NO. 2 in BMEWS net—Command and Control System 474L—recently went into operation at Clear, Alaska.

mand structure. In doing so, the Aerospace System would be tied in with other generally independent systems such as the *Polaris* Fleets' communications net.

Essentially, ESD and Mitre would have the job of assuring flexible national command and control of all U.S. Armed Forces.

• **By ADSID out of SAGE**—The buildup of ESD and the Mitre Corp. began in 1958 with the establishment at Hanscom of what was then called ADSID—the Air Defense Systems Integration Division.

The Air Force established ADSID to handle the integration and engineering work on the SAGE continental air defense network which had been developed by MIT's nearby Lincoln Laboratory. Mitre was established in September, 1958, to provide ADSID with technical support not available within the Air Force.

The non-profit corporation was built around a nucleus of SAGE scientists and engineers who transferred from Lincoln Laboratory. C. W. Halligan, director of military engineering at Bell Telephone Laboratories, was named president.

In 1960, ADSID was expanded into the Air Force Command and Control Development Division—nicknamed C^2D^2—and assigned the development of all Air Force command and control systems. The Electronic Systems Center at Hanscom had responsibility for production of the systems. Finally, last April, the two agencies were joined to form ESD.

• **Growth**—Throughout these various reorganizations, the Air Force has continued to expand and strengthen their own and Mitre's operations.

Today the corporation's payroll has grown to about 1500 people including a professional staff of about 500. About 10% have doctorates; about 35% of the rest of the professional staff have master's degrees.

Contracts for FY '62 to date are expected to total about $30 million. Some $27 million of this is from the Air Force. The rest is from other military agencies and FAA. Contract fees —they average about 5%—are being used for construction of facilities.

The corporation is divided into three major groups: Systems Planning and Research, Systems Engineering, and Control and Sensor Systems Development.

• **Uniqueness** — But numbers and organization tables do not tell the story. The essential contribution of Mitre is based on the fact that the company has put together a unique group comprised of many of the nation's top experts in electronic command and control systems.

Mitre describes its current operations as: "Advanced system analysis and planning, intersystem integration, general system engineering, initial system design, technical advice and research and experimentation."

All of this is not provided for each "L" system. For many of the systems, Mitre provides only small amounts of technical advice on request. The bulk of Mitre's major efforts is concentrated on a few systems.

However, it is in work on these few systems that the trend of the corporation's future operations as planned by ESD can be clearly seen.

A prime example is 425L—the NORAD Combat Operational Center. Here Mitre is doing the system design works and assisting ESD in making sure that this design is followed.

In the near future, ESD is expected to assign Mitre the same role on at least four other systems: two that are now in existence as projects and two new ones. Some possible new systems currently under analysis are an Advanced Aerospace Offensive System (601L), an Advanced Aerospace Defensive System (602L), and a Tactical Forces System (603L).

• **Working closely** — The essential factor needed for fully understanding Mitre's role in the development of these systems is an understanding of the nature of the command systems themselves. As Charles A. Zraket, Mitre technical director of systems planning and research, put it recently:

"Weapons can be designed and built and handed to the user. But the command and control of a missile and its tactical use are problems that you can not separate from the user and his organization. Therefore, it is very important that we work very closely with the user."

Command is a military job. Theoretically, it would be best for the user to do it—to design his own electronic command system—because he has been doing this job for the last 2000 years. But command and control can no longer be exercised by dispatching couriers or looking up troop dispositions in log books when ICBM's flash across oceans in 30 minutes. Digital computers pro-

(Continued on page 40)

Enos orbits twice...

Big Add-on Program for Mercury Planned

NASA IS EXPECTED shortly to follow-up the successful two-orbit flight of a chimp with plans for a $400-million add-on to the *Mercury* program involving two new spacecraft.

Meantime, troubles which developed aboard the *MA-5* chimp capsule while in orbit Nov. 29 virtually killed the last slight hope of a manned *Mercury* orbital flight this year. The difficulties also prevented the capsule from making its programed third orbit.

Prior to the shot, NASA officials had tentatively set a date in late December for the manned attempt. But the *MA-5* capsule developed an inverter overheating problem, along with a hydrogen peroxide roll-jet malfunction, which has prompted a new evaluation of the manned *MA-6* timetable.

Mercury officials indicated that both of the trouble spots could have been overridden by a man. But they said the data would have to be examined, taking about 10 days, to determine if changes would be needed—cutting deeply into the dwindling remainder of 1961.

The *Mercury* add-on, MISSILES AND ROCKETS has learned, would mean modifying a present *Mercury* capsule so that it could sustain a man for an 18-orbit trip, and building a brand-new capsule which would carry two astronauts on earth-orbital flights lasting more than one week.

Intended to bridge the gap between *Mercury* and the start of *Apollo* three-man flights in 1964, the 18-orbit flights would be attempted in late 1962 or early 1963 and the two-man flights in 1963 and early 1964. The plan, which would have to receive Administration and congressional approval, is understood to have been advanced by McDonnell Aircraft Co., prime for *Mercury*.

• **Clean getaway**—The long-delayed *MA-5* shot, hit by a hydrogen peroxide leak which prevented a launching Nov. 14, got off cleanly from Cape Canaveral at 10:07 a.m. Nov. 29, three hours later than scheduled. There were holds of 1½ hours because of a telemetry problem in the capsule and for 15 min. while a communications link between the capsule and command center was rechecked.

The chimp—named Enos and one of five specially trained for the flight—rode in a special Environmental Control System (M/R, Nov. 13, p. 16) that permitted him to perform certain tasks that were monitored by TV and telemetry. During the 181-min. flight, about 170 min. of it weightless, doctors reported Enos "didn't miss a trick" and scored almost 100% on his tasks.

Excessive heating of two inverters was detected midway in the second 146-96-n.-mi. orbit as the capsule sailed over Woomera, Australia. The heating pushed the capsule's interior temperature to 100°F and the chimp's closed life support unit to 80°.

• **Saving package** — A decision to cut short the flight was made as it approached Point Arguello, Calif., and the spacecraft's retros were triggered from there for the descent. NASA officials said later they thought the capsule could have completed three orbits, but they saw no reason to risk losing the experiment.

They said that if a man were aboard he could have controlled the heating problem by switching to a third inverter, allowing the other two to cool down. He also could have shut off the roll jet which was malfunctioning.

The descent was terminated in a near-perfect recovery operation added by calm seas. Impacting in the water at 1:08 p.m. EST, 220 mi. south of Bermuda, the capsule was picked up by a helicopter at 2:53 p.m. and brought to an aircraft carrier. Doctors aboard the carrier said Enos appeared to be in excellent health (he underwent 7½ g's at liftoff) and had functioned normally throughout the flight.

Enos was the first chimp orbited by the U.S. in a dress rehearsal for a manned *Mercury* flight. Whether a second chimp shot will be conducted was uncertain last week. There was a possibility one might be ordered before or after a manned flight.

• **Glenn choice confirmed**—On recovery of the chimp NASA announced that Astronaut John H. Glenn (M/R, Nov. 20, p. 9) would be the first U.S. citizen to try to duplicate the feat of Russian Maj. Yuri Gagarin last April 12. Malcolm S. Carpenter will be Glenn's backup. Astronaut Donald K. Slayton was tapped for the second manned *Mercury* orbital flight, with Walter M. Schirra as backup. ¤

Rendezvous Check

Golovin Group Ordered To Re-examine Concepts

TOP KENNEDY Administration officials have ordered the Golovin committee to take a new, hard look at one of its major recommendations—orbital rendezvous.

The new meetings—with primary emphasis on the propulsion and guidance to be used—will continue from two to four weeks.

Usually reliable sources report that the meetings were called by the White House because of new intelligence information.

This was denied by NASA and Defense Department public information officers. The meetings were termed "simply routine."

Other top NASA, DOD, and White House officials disclosed that the meetings were not routine, but were of a serious, special nature.

As one official put it, "It is clear that orbital rendezvous is needed not only for the manned lunar landing program but also for further manned interplanetary exploration, and for such military uses as intercepting, inspecting and even destroying hostile satellites or space stations."

In effect, he said, the Golovin committee has been told to take another look at its recommendations to insure that they will not only fill the requirements for Project *Apollo*, but also the needs of further programs and the DOD.

In particular, the areas of guidance and propulsion for orbital rendezvous are to be further explored to insure that the state of the art is sufficient to solve the difficult problems involved in mating two spacecraft while in orbit.

• **NASA-DOD split?** — The same sources also report that there is friction between NASA and DOD members of the committee which was set up to study the long-term needs of the space program—with emphasis on required launch vehicles. This could stem from the desire of the Air Force for a greater role in developing the orbital rendezvous concept and a DOD belief that NASA plans for rendezvous will not fill the total needs of the space program.

The Golovin committee's major recommendation—when it originally wound up its work about three weeks ago—was that orbital rendezvous be pushed as the best method of achieving a manned lunar landing. The *Saturn C-4* with four F-1 engines was proposed as the launch vehicle for the *Apollo* spacecraft. ¤

NASA, NAA Making Apollo Plans

Early work on craft design pays off for firm with valuable experience on X-15; team must still be assembled

NORTH AMERICAN Aviation begins talks with NASA this week on the management program and subcontracting structure for the three-man *Apollo* spacecraft which is to land a team of American astronauts on the moon by 1967.

Selection of North American as the winner in one of the most important competitions ever held in the missile/space industry was announced by the space agency on Nov. 28. NASA said the contract to be negotiated with NAA will be worth $400 million in its initial phase.

The spacecraft will be built at NAA's Space and Information Systems Division in Downey, Calif. North American is to develop two sections of the capsule. It also will be in charge of integrating the work of other contractors on the program still to be named by NASA.

The NASA announcement specified that North American will develop the command and service modules of the spacecraft. The lunar landing and orbiting laboratory modules are to be developed under separate associate contracts to be awarded within six months.

• **Payoff**—North American already is at work on engineering of the *Apollo* craft. A team of some 90-100 engineers continued work following submission of NAA's bid in the competition.

"We haven't stopped," division President Harrison A. Storms Jr. told MISSILES AND ROCKETS. "It was a gamble to save time that paid off."

The decision to keep the team at work was made in an effort to achieve a better understanding of the total design problems and to nail down concepts in advance of talks with NASA which will firm up the program, Storms said.

Four major subcontractors worked with North American on the proposal that was submitted to NASA: AiResearch Division of the Garrett Corp. on life support; Minneapolis-Honeywell on secondary guidance and control; Collins Radio on communications; Radioplane division of Northrop on the parachute recovery system.

NASA said prior to the award that it would not necessarily accept the teams that bid in the competition. Final makeup of the subcontracting team is one of the items to be discussed in the talks between NAA and NASA.

"We think they will go with this group, but that is one of the things to be decided," Storms said.

Unsuccessful bidders in the competition were General Electric with Grumman Aircraft, Space Technology Laboratories, and Douglas Aircraft; McDonnell Aircraft with Lockheed Aircraft, Ling-Temco-Vought and Hughes Aircraft; General Dynamics with Avco; and Martin-Marietta Co.

• **General surprise**—Announcement of the award came at least a week earlier than anticipated by most of the competitors, catching North American as well as the unsuccessful entrants by surprise. Late-afternoon announcement of the winner came hard on the heels of a strong rumor earlier in the day that General Electric had won the competition.

NASA had no explanation for the early announcement other than to point out that it had said the award would be made as soon as possible. The agency said nearly 200 engineers and scientists in both NASA and the Department of Defense had evaluated the proposals of the five contractors or teams bidding on the *Apollo* prime contract. Unsuccessful bidders will remain in contention for other *Apollo* contracts, including positions on the North American team.

June 30 of next year is the deadline for assembling of the industrial team which will build the spacecraft.

SISD President Storms said a team of about 1000 will be assigned to the project at the Downey division. It will be set up as a separate and integral organization assigned to *Apollo* for the full life of the program.

(Continued on page 38)

New Name and Mission Changed Division's Fortunes . . .

STORMS

NORTH American's Space and Information Systems Division changed its name and its fortune just about one year ago.

Since that time, the space-oriented business of the newly named prime contractor of the *Apollo* spacecraft has mushroomed—including awards of $599 million in new contracts in the last 90 days.

Much of the credit belongs to Harrison A. Storms, Jr., division president.

The division orginated in 1946 as a handful of scientists known as the "Aerophysics Lab" located in a tiny corner of NAA's Los Angeles division. The future of the group was very dim several years ago, when its contract for the *Navaho* missile was cancelled.

Struggling along on contractual odds and ends, the division eventually won the contracts for the *Hound Dog* missile and NASA's *Little Joe* booster.

The big break came last December when its name and mission were changed. Instead of unmanned projects, the division began to specialize in space systems.

Since that time, the record has been good. It holds two study contracts with NASA — one for a paraglider for booster recovery and the other for a self-erecting space platform. In addition, it has won the $140-million contract for the *S-II* stage of the *Saturn* booster and the *Apollo* award of over $400 million.

Its employment roster has reached 7800, with 1300 hired since the name change.

One interesting proof of the division's progress is that the $599 million in contracts in the past 90 days contrasts with total divisional sales of only $108.1 million in all of Fiscal Year 1961. ¤

Progress Report . . .

Late '63 Launch Still Goal for OAO

NASA's heaviest unmanned satellite to provide best look at stars; Grumman's $3-million investment

by Michael Getler

NASA IS STILL hoping for a late 1963 launching of the telescopic Orbiting Astronomical Observatory (OAO) —intended to provide U.S. astronomers with their first unimpaired glimpse of the universe.

Here's how the $30-million program stands today—one year after its initiation:

—Fabrication of an engineering prototype is under way at Grumman Aircraft Engineering Corp.'s Bethpage, L.I., plant. Grumman, the prime contractor, expects to complete this phase late next year or early 1963.

—First flyable version is expected to be delivered in August, 1963, and a second unit two months later.

OAO, a 3300-lb. satellite crammed with 1000 lbs. of instruments, is to be lofted into a circular 500-mi. orbit with an *Atlas Agena B*. It will be NASA's heaviest unmanned satellite.

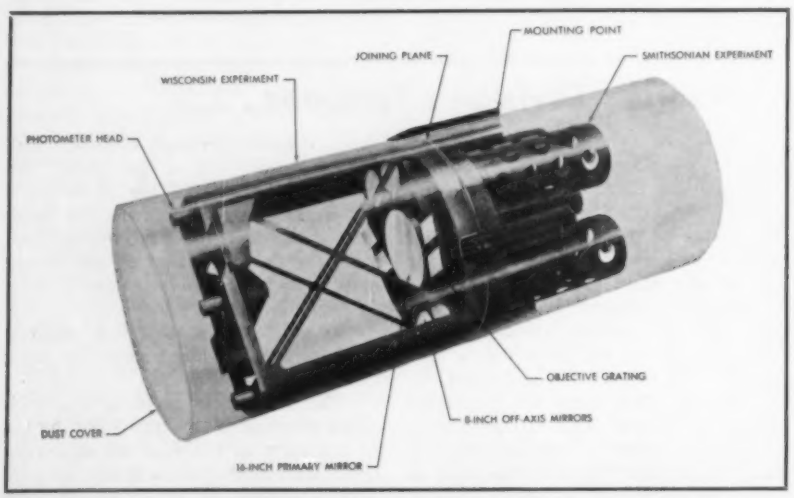
The two major experiments to be carried by the first OAO will involve stellar observation in the ultraviolet region. One is being prepared by the Smithsonian Astrophysical Laboratory and the other by the University of Wisconsin.

The SAL experiment will map the entire celestial sphere in uv to 1100 angstroms (the region below 3000 angstroms is obscured to terrestrial observatories due to the earth's atmosphere). Brightness intensities of at least 200,000 hot-stars (temp. ranges between 10,000-50,000°K) will also be recorded with the SAL package. The experiment will utilize a cluster of four eight-in. telescopes, each coupled to a video tube, to mape the uv radiation patterns.

Determination of stellar energies in the 3000-8000 angstrom region will be undertaken by the University of Wisconsin equipment. This is the area which can be measured, in part, by present observatories on earth, but considerable question exists concerning accuracy of the measurements.

The two observation experiments will require both ends of the spacecraft shell to be open.. It will also require sun shades at both openings. Under normal circumstances, only one sun shade would be needed with the OAO aft-end closed and fully insulated.

Experiments slated for the second OAO are being supplied by NASA's Goddard Space Flight Center. A 36-in. cassegrain telescope with a wide-aperture spectrophotometer will collect data on specific stars, galaxies, and nebulae. Studies of the sun and planets, and investigation of the absorptive characteristics of the interstellar medium will follow.



EXPERIMENTAL PACKAGE for first OAO includes stellar observation equipment contributed by U. of Wisconsin (left) and Smithsonian Astrophysical Laboratory.

• **Steadier than earth** — Margin of error in the OAO telescopes during stellar tracking will be .1 sec. of arc—a feat roughly equivalent to locking onto a basketball at 500 mi. Hence, enormous advances in satellite stabilization and control are demanded.

Indeed, Grumman hopes to make the satellite's platform even more stable than astronomical observatories on earth, where data collection can be hampered by even slight terrestrial vibration. To achieve this and other design objectives, the company has put up $3 million in new facilities to assemble and test the vehicle. They include:

—A 17 by 26 ft. high-vacuum environmental space chamber, capable of housing a complete OAO and simulating thermal conditions 200 miles in space. Atmosphere within this chamber, which allows full temperature and humidity control, can be decompressed to 10^{-7} mm of mercury.

—A 30,000 lb. vibration "shaker," able to impart a 3300 lb. force between 1 and 200 cps to the completed satellite.

—A dust-free, temperature-and humidity-controlled clean room, large enough to accommodate complete assembly of prototype versions of the OAO and all components and sub-systems. Complete equipment for checkout of satellite systems and alignment of all sensing networks is also installed.

• **New facilities**—Grumman began construction last week on a new stabilization and control dynamic test facility, destined to house what company officials feel may be the world's largest three-axis air-bearing spacial simulator.

This device, used for development and testing of the OAO's unique and extremely precise stabilization and control system, is expected to allow a torque sensitivity level below 1000 dyne-centimeters. The 104-in. table of the new

simulator will rest on a 22-in. steel ball-bearing ground to within 50 millionths of an inch sphericity. The table will support up to 7000 lbs. of OAO developmental hardware and test equipment.

A smaller air-bearing table is already in use. But the 72-in. platform on a 10-in. ball holds only about 700 lbs. of equipment.

Surrounding the new simulator will be three Helmholz coils to simulate the earth's magnetic field, providing complete simulation of the spacecraft's moments of inertia.

Also included in the new area will be a solar simulator capable of emissions 40% as intense as those of the sun, and six stellar simulators. Baffles are included in the test bay design to minimize air currents and reduce reflection of stray light from the solar simulator to which the air-bearing platform would react.

The new dynamic test facility—to be ready next spring—will cost an estimated $150,000. It will be constructed on a spring-mounted concrete seismic foundation to provide the necessary vibration isolation.

Earlier this year, Grumman opened a new 65,000 sq. ft. electronic system center. Now fully staffed and operational, the electronics center is involved with several OAO projects, including testing of the satellite's turnstile transmitting antennas in what is believed by Grumman to be the largest r-f anechoic chamber in existence. The room measures 110 ft. long by 40 ft. wide by 25 ft. high.

• **Tough tests**—Over-all testing of the OAO prototype unit and all subassemblies will be based upon levels 1.5 times as severe as those anticipated during actual launch and orbital conditions. Testing of flight models, both by Grumman and NASA, will be accomplished at levels comparable to those actually anticipated during flight. A reliability goal has been established for the OAO at 70% probability of operating in orbit for one year.

Here's the flight sequence once OAO is orbited:

After separation from the *Agena-B* booster, a series of rate gyros sense the satellite's tumbling momentum and set up an error signal. This signal activates a gas jet system which halts the initial motion.

Solar sensors then seek out the sun and align the optical end of the OAO away from the sun and towards the earth.

Now stabilized in pitch and yaw with respect to an earth-sun line to within ±.25°, the gas jets are activated in conjunction with momentum wheels and roll the observatory around the optical axis at approximately 2 deg/sec.

As the satellite rolls, the six precision star trackers, one on each of four sides and one on each end, seek pre-determined stellar targets. Initial reference can be established through lock-on by two or more star trackers. It is possible to pre-select a set of six tracker pointing angles so that there is only one roll orientation at which all six reference stars will be encountered.

Once roll orientation is established, the OAO can be slewed towards any arbitrary position in space by the star trackers and a momentum-transfer system utilizing three sets of inertia wheels. Each set contains a large wheel for coarse slewing to within an accuracy of one minute of arc and a smaller wheel for the fine, or ultimate, guiding capability of .1 sec of arc. The drift rate during fine control pointing is .1 sec arc/per sec.

A television installation is also incorporated in the OAO design to serve as a back-up for orientation purposes.

The problem of excessive vehicle angular momentum resulting from disturbance torques which act continuously on the OAO has been treated in a unique fashion by Grumman.

• **Magnetic unloading**—During star-acquisition and attitude-hold phases of operation, the fine momentum wheels are sufficiently accelerated to cause an-

(Continued on page 39)

FULL-SCALE MOCK-UP of NASA/Grumman OAO is set up at company's Bethpage location. Small domes (top and lower right) house satellite's star trackers.

Second Contract Due

Award of a contract for fabrication of the Smithsonian portion of the OAO experiment is expected this week.

The Cook Technological Center in Morton Grove, Ill., has already been selected to do the bulk of the design and fabrication for the U. of Wisconsin package. Armour Research in Chicago is doing the optical design, and the university is fabricating the stellar detectors.

Both experiments should be available for assembly with the first prototype OAO.

JEEP-MOUNTED Entacs ready to fire. Antitank missile may also be launched from armored vehicles and helicopters.

ONE-OPERATOR field mode for Entac battery. Big wallop packed by lightweight missile is spurring production.

U.S., Belgium among buyers . . .

Demand for Entac Boosts Production

by Jean-Marie Riche

PARIS—France's potent *Entac* antitank missile—now being phased into French Army infantry units—is headed for greatly stepped-up production.

Although some 10,000 *Entacs* already have been turned out by Atelier de Construction de Puteaux for DEFA (the French Army R&D agency), starting early next year Nord Aviation will become a second source.

The United States, moreover, has signed a licensing agreement with the French government under which it can order the manufacture of more of the missiles. (Sources in Washington said this week that as yet no U.S. contractor for *Entac* had been sought.)

• **Market swells**—Increased output of *Entac* is being brought about both through a French Army decision to replace all Nord *SS-10's* now in infantry units and an apparent large demand for the weapon by the U.S. and several European nations. The French say that *Entac* has undergone two test series in the U.S. and a number of countries, including the U.S. and Belgium have placed orders in both operational and test quantities.

With this disclosure the French also reported new details of the *Entac*. Weighing just 26.4 lbs. in flight, the 32-in.-long, 17-in.-diameter bird can carry two types of warheads—an all-purpose round designed for use against both personnel and armor, and an antitank round described as "the most powerful charge in service for missiles of this type."

Effective range of the wire-guided missile is 1300 to 6600 ft. The 28.6-lb. command equipment can be handled by one operator employing a lever which the French call a "broomstick handle."

One of *Entac's* features is reported to be a long field life—attributable to a new "primer battery" which does not have to be replaced even after lengthy duty in the missile. ⌗

FIRST PHOTO of Entac armed with tank-piercing #130 warhead.

ENTAC COMMAND unit weighs 28.6 lbs., contains missile selector and C&C.

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Technical Countdown

ELECTRONICS

Move to Scotland Accelerates

More and more U.S. and British electronics manufacturers are expected to open new facilities in Scotland during the next few years. A broad, skilled labor market, available at appealing wage rates; an eager Board of Trade; the introduction of a new, economical, fast air-freight service; and the lure of the European Common Market could double Scotland's electronics industry, observers say.

AEC Arms Itself for Tests

Starting next week, the Atomic Energy Commission will fire miniaturized telemetry and other instrumentation from two 155mm guns to test new components under high-g loads. The six-month test program will be conducted at the AEC's Tonopah Test Range in Nevada. Accelerations over 1200-g will be experienced by test items within the projectiles, and data will be telemetered to a series of ground stations. The two 15-ton artillery pieces have been furnished for the tests by the Benecia Arsenal, Calif.

Now It's Instant Antennas

First of the new "billboard"-type stationary paraboloidal-reflector antennas designed by Boeing Company will be installed for a communications link on the Ryukyu Islands. Ordered by Page Communications Engineers, Inc., for a troposcatter system, the 30-ft. dish can be erected by eight men in about 25 hours. Installation savings, says Page, will amount to $5000 per 60-ft. antenna. Erection time is cut in half through use of precision-formed and drilled steel girder construction, preformed surface parts, and sequence packaging. Antenna widths available are 30, 60 and 120 ft.

Mariner Command System Selected

A highly sophisticated flight command subsystem will be developed by Motorola for the *Mariner "R"*, Venus flyby spacecraft, says Jet Propulsion Laboratory. The spaceborne system will receive binary data in phase-shift-key form. Using pseudo-noise techniques, synchronization will be obtained through an advanced coding scheme. In operation, the system processes all on-off commands for other subsystems and programs the control computer. First of the seven launches for the 450-lb. satellite is scheduled for mid-1962.

Fast Slough Antenna Planned

The British plan to complete their new 85-ft. radio telescope at Slough, a suburb of London, by 1963. The fully steerable antenna will complement the 250-ft. dish at Jodrell Bank. Featuring very fast tracking speed, the $700,000 Radio Research Station antenna is designed specifically for earth-satellite tracking.

Prototype ECCM System Delivered

A new mobile transistorized electronic countermeasures system has been built by Sylvania Electric for the Army. For use with field radar units, the system employs a digital computer for advanced target-locating techniques to counteract aircraft jammers. In development since 1955 under a $3-million program, the prototype system is van-carried and occupies 250 cubic ft. Operational systems could be reduced in size to about 150 cu. ft., Sylvania says.

ADVANCED MATERIALS

Explosive Forming in the USSR

Metal-forming plants in the Soviet Union are being urged to adopt explosive forming methods. Experiments in the forming of automobile floors are being performed at the Balashikha plant. The process here is carried out under water with an explosive charge. It handles several deep-drawing, forming, blanking and flanging operations simultaneously.

Spectra of Space Radicals to Be Determined

Paramagnetic resonance techniques are being used by the Bureau of Standards to determine frequencies capable of detecting the radicals believed to exist in outer space. Measurements have been completed on the OH radical and the equipment is being modified to handle the spectra of the shorter-lived CH and SH radicals. Once the frequencies are accurately known, the bandwidth of the receiver can be minimized for radiotelescope searches.

Oxygen Removed from Gyro-Bearing Fluids

An intensive research program by AC Spark Plug Co. scientists has enabled them to eliminate even infinitesimal amounts of oxygen from the liquid bearings of precision gyros, the company announced recently. Since the effects of oxidation in gyros are a prime cause of gyro failure, the company said, the elimination of the oxygen should lead to longer gyro life with consequent savings in money and materials.

ASTRONAUTICS

Echo TV System Under Development

A TV camera—mounted on the final stage of the *Echo* satellite launch vehicle—is under development by the Siegler Corp. for Goddard Space Flight Center. The camera will allow designers of the inflatable satellite to study the ejection techniques of the balloon. Information transmitted to earth from the camera will also be permanently recorded on film and magnetic tape.

SUPPORT EQUIPMENT

Space Simulator for OSO Delivered

A 10-by-15-ft. space simulation chamber—designated "Envirovac" by its designers, the High Vacuum Equipment Corp.—has been delivered to Ball Brothers Research Corp. for component and satellite environmental testing of NASA's *Orbiting Solar Observatory (OSO)* satellites. The chamber is capable of attaining pressures of 2×10^{-8} Torr—roughly equivalent to 275 miles altitude—without the use of heat or liquid nitrogen in the cryo-panel.

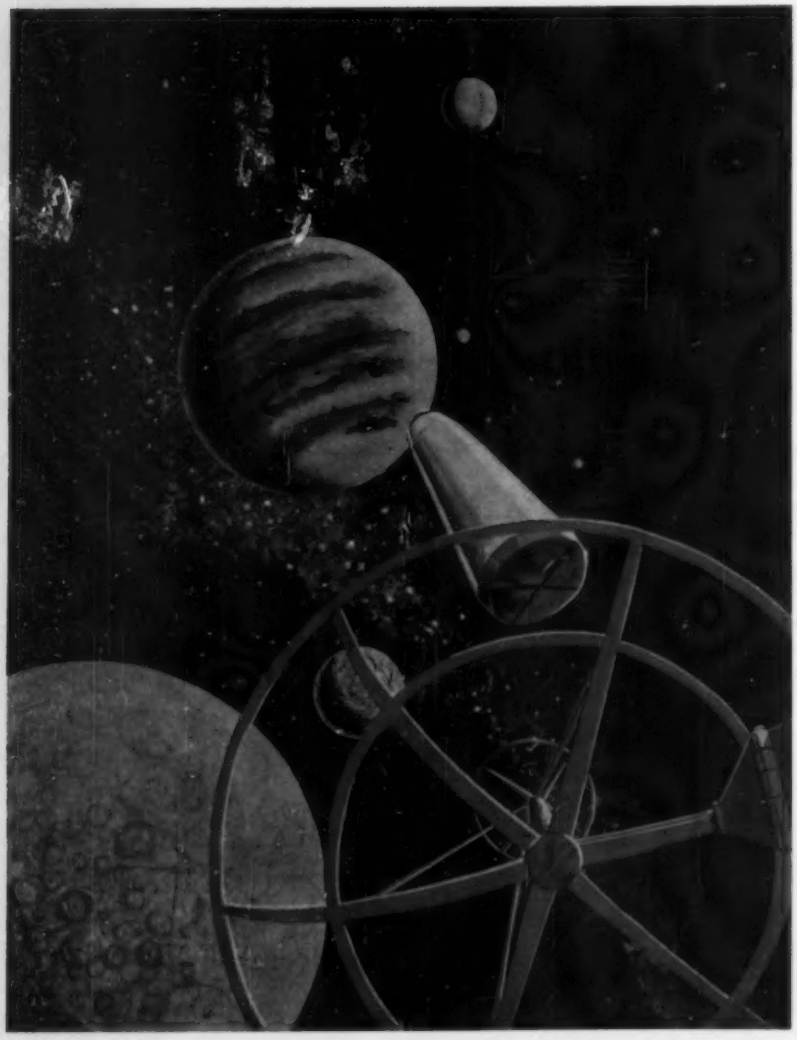
Hercules Targets to Be Simulated

A target simulator device capable of providing *Nike-Hercules* units with targets resembling almost any enemy bomber is being installed at White Sands Missile Range, according to ARADCOM officials. The system—packaged in a single mobile van—will be used during annual firing tests of *Nike* batteries. Its main advantage, said one Army spokesman, is that unlike the drones previously used for the firing exercises it will effectively train radar operators to recognize and track a variety of high-performance aircraft.

Jupiter—Probe Target After Mars

Mars fly-by in '64 will supply guidance and booster know-how; gravity toughest problem

by Robert L. Forward



ARTIST'S CONCEPT of spacecraft view of our largest planet, Jupiter, through high-gain antenna. Departing probe on right seeks data on Jupiter's atmosphere. Europa, one of Jupiter's 12 planets, is shown at left.

JUPITER is the logical next target, after Mars, for an unmanned probe.

Although NASA has not yet drawn plans for such a probe, a substantial part of the needed technology—guidance and booster propulsion—will be in hand if the scheduled 1964 Mars fly-by is successful. Moreover, electrical propulsion units, which are needed for "long-distance" flights, are also expected to be available in the mid-60's.

The remaining pressing problem is to get a probe and instruments strong enough to survive in the crushing pressures near Jupiter's surface. Here is an entirely new field for space technologists to explore—and one that will probably be the pacing factor for Jupiter craft.

Jupiter is one of two bodies in the solar system that man will not be able to exist on for any extensive period of time. (The other body is the sun.) Man can overcome heat, cold, vacuum, radiation and poison gases merely by properly constructing his protective shells, but he can't—as yet—shield against gravity. Jupiter has a surface gravity of 2600 cm/sec^2 (2.65 g's), which is mollified only slightly by a centrifugal acceleration of -225 cm/sec^2.

But 2.6 g's does not rule out a short trip by man to Jupiter. In a recent experiment a man lived in a 2-g centrifuge for 24 hours, without protective clothing, to study the consequences of long-duration acceleration. He cooked, ate, slept, stood up, made medical self-observations, and generally carried out other living activities. However, he lost interest in these activities while under stress, and passed most of the time listening to the radio and napping—no way to make precise scientific investigations.

If a manned investigation of Jupiter becomes necessary—and if we develop the rocket power necessary to overcome the gravitational attraction—a man will be able to go down into the upper

regions of Jupiter for a short period of time. He will have to wear a g-suit and be in excellent condition, but he will be able to carry out a limited amount of experimental work under the high gravitational forces.

The vehicle used in the atmosphere could take many forms. The most obvious method is to use a high-performance jet aircraft, except that instead of carrying the fuel and scooping up oxygen as a jet does on the earth, a Jovian jet will carry the oxydizer and scoop up the fuel in the form of hydrogen, methane and ammonia.

It is doubtful that a manned investigation will prove necessary; we will probably have to content ourselves with observations from orbit and measurements with unmanned probes.

• **The Planet** — Through the telescope Jupiter appears as a golden ellipse with many dark bands parallel to the equator. The dark bands mark the Jovian equivalent of our trade winds. The clouds which form the bands consist of small ammonia crystals suspended in the atmosphere. The various colors observed are caused by contamination of the ammonia crystals with traces of metallic compounds such as sodium.

Jupiter's elliptical shape is due to its thick atmosphere and rapid rotation; its period of revolution, however, is not fixed but depends upon the particular part being observed. Although the equatorial region has a rotation period of 9 hours 50 minutes, most of the rest of the planet rotates at 9 hours and 55 minutes. Various other special features have their own rates of rotation.

Calculations based on the polar flattening have shown that there should be a rapid increase in density from the surface to the center. Since Jupiter's specific gravity is only 1.3, this requires that the outer layers of Jupiter be a gas. Observations of a star as Jupiter passed in front of it gave an average molecular weight for the gas of 3.3 This indicates that the atmosphere of Jupiter is mainly hydrogen and helium, with small amounts of methane and ammonia.

There is still a difference of opinion as to the internal structure of Jupiter. Some suggest that it has a rocky core, a layer of compressed ice containing all the oxygen of the planet, and a deep atmosphere of compressed hydrogen gas with a density of 0.35 just above the ice layer. Others insist that Jupiter has a much higher percentage of hydrogen.

If the planet does consist mostly of hydrogen, there will be no true surface under the atmosphere. As one goes deeper into the atmosphere, and the pressure increases, the hydrogen gas will get denser and denser. Near the center it will be so compressed that it will start to behave like one of the alkali metals.

Even if we knew the composition of Jupiter, the only way to determine its actual structure would be to send probes down into the planet. A great deal depends upon the temperature gradients and heat sources inside.

• **The Great Red Spot**—Spots are very common on Jupiter, the most famous being the Great Red Spot. It first became prominent in 1878, slowly turning from a small pink oval to a large brick-red area 30,000 miles long by 7000 miles wide. After this occurrence, older drawings were examined and traces of the spot were found to have existed as long ago as 1664. Since 1890 it has faded considerably—as if it had sunk down into the atmosphere slightly.

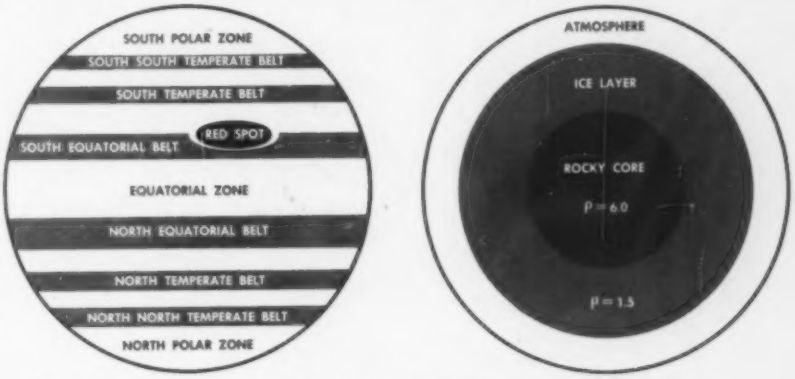
The Red Spot does not rotate uniformly with the planet but drifts about considerably; it once wandered away from its mean position by nearly a quarter of Jupiter's circumference. Such freedom of motion shows that the Spot is a floating disturbance. Other semi-permanent markings are observed on Jupiter's surface; all of them wander about, showing that the Jovian atmosphere is deep and complex.

Another feature merely adds to the puzzle. This is the South Tropical Disturbance, a dark area which is in the same zone as the Red Spot but has a shorter rotation period and laps the Spot every few years. It approaches the Spot at several miles an hour, speeding up at it nears, then seems to drag the Spot along with it for several thousand miles. After the interaction, the Great Red Spot drifts back to its mean position while the South Tropical Disturbance continues on its next lap. The variety of motions show that a continuous volcanic action cannot be responsible for either spot.

• **Satellites**—Jupiter has a family of twelve satellites, but only four of them are large enough to be dignified with names: Io, Europa, Ganymede, and Callisto. The known characteristics of the larger satellites are given in the accompanying table (page 26) along with those of Jupiter.

Two of the satellites, Io and Europa, are similar to our moon in size, mass and density, and are probably made of rock. Ganymede and Callisto, however, have much lighter densities and must contain a high percentage of lighter materials, probably ice and frozen ammonia over a rocky core.

It is an interesting fact that although the four satellites are all within a short distance of each other and all are comparatively small, traveling between them would involve almost as much power as does a journey between the inner planets. This is because the gravitational influence of Jupiter cannot be ignored in a calculation of the escape velocity. For instance, the escape velocity for Io is roughly 27 km/sec. But only 2.5 km/sec is due to the mass of Io; the remainder is required to escape the gravitational influence of Jupiter.



LEFT: *The band structure of Jupiter, including the well-known Great Red Spot.*
RIGHT: *Wildt's model of Jupiter.*

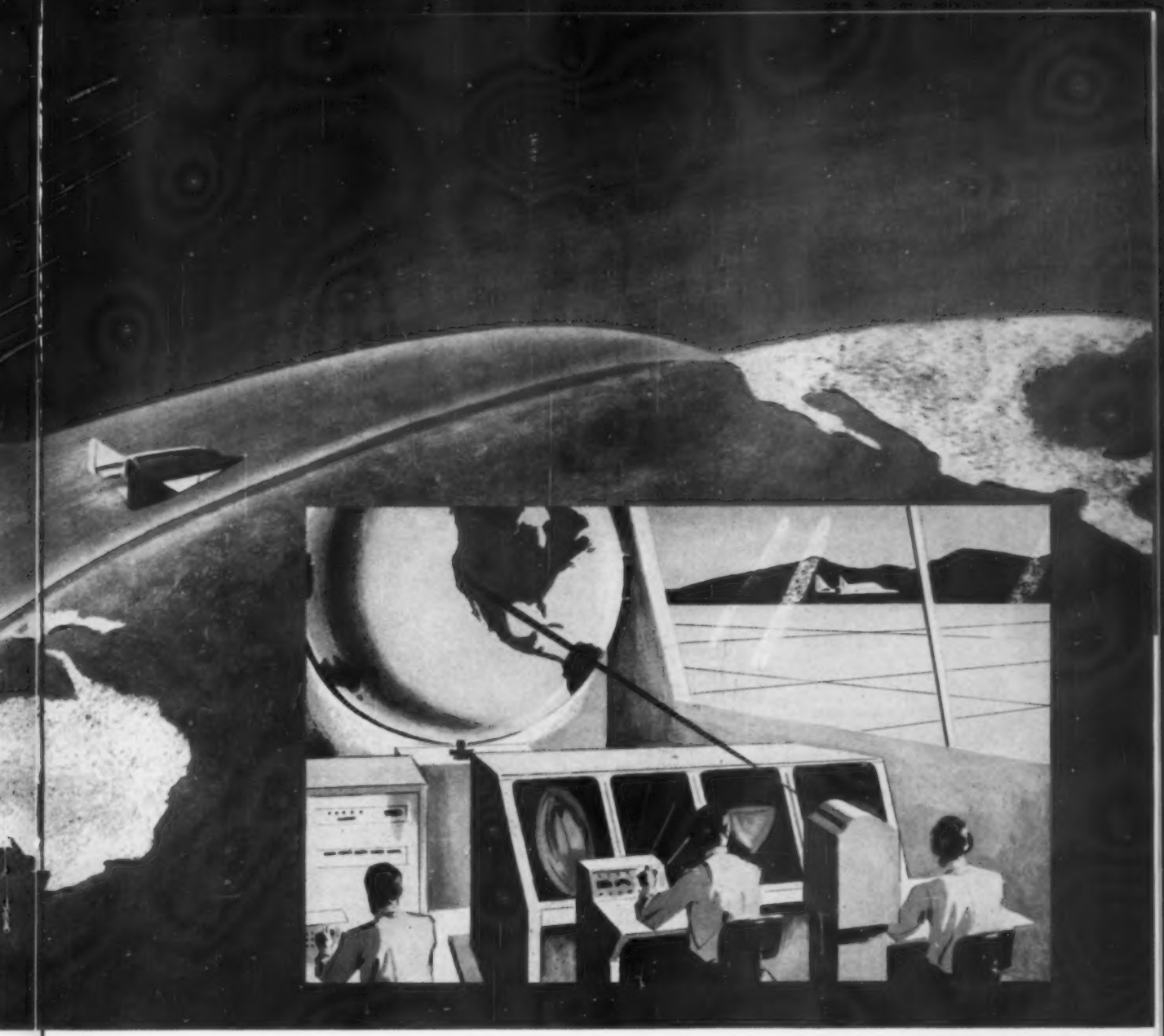
• **Radio emission from Jupiter**—In 1955, intense bursts of radio noise were found to be coming from Jupiter at decameter wavelengths. The radio waves seemed to come from several regions or Jupiter; in particular, from the three large white spots in the South Temperate Belt and the Red Spot when it was near one of the white spots. The amount of energy released in radiation is tremendous. Various speculations have been made concerning their origin: lightning or chemical reactions in the atmosphere, volcanic explosions, or trapped solar particles in a gigantic Jovian Van Allen Belt.

Recent experiments seem to favor the solar particle theory. The radiation is predominantly right-handed elliptically polarized, which points to a magnetic interaction origin. Also, during the last opposition of Jupiter, both the earth and Jupiter were sprayed by high-energy particles from solar flares. There was a definite correlation between the flares from the sun, magnetic storms on

Raytheon solution for space

Recovery of space vehicles is a long range problem, commencing at atmosphere entry. Techniques for control from re-entry through touchdown, developed by Raytheon, are comparable to GCA concepts. Over the past two years, Raytheon has conducted a major and continuous investigation of the means by which a manned maneuverable space vehicle can be returned safely from flights in space to normal routine landing on earth. These investigations have included operational control concepts, instrumentation, information flow analysis, basic system requirements and subsystem specifications.

Part of this effort was a space vehicle recovery study for the Air Force Flight Test Center encompassing vehicle energy management, glider characteristics, trajectory analysis, flight parameter accuracies, range instrumentation, navigation, communications, data processing display, and human factors.



vehicle recovery: LONG RANGE GCA

Other portions of the effort included earth return navigation and recovery studies for SLOMAR (as a subcontractor to the Martin Company), and joint efforts with Bell Aerosystems Company on DYNA-SOAR Terminal Navigation Systems.

Currently, major emphasis is being placed on the APOLLO Ground Operational Support System (GOSS). This system will include global range instrumentation for tracking; telemetry and communications; and control, display and computation centers.

One of the world's largest scientific-industrial organizations, Raytheon has proven capability to create the required technology and manage every phase of a space vehicle recovery system — from early study and design through development, production and field support of operational systems and equipment.

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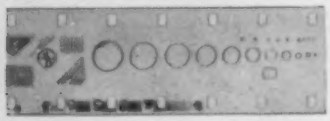
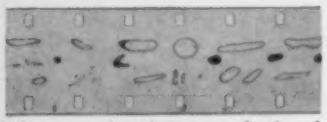
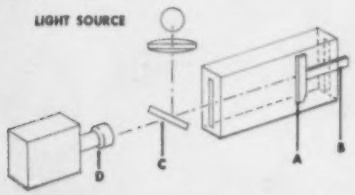


Above, actual size, is a test film of circles and numerals placed within a 1/32"-wide channel.

Above is a *panoramic* view of a continuous section of the same film . . . with marks enlarged 8x.



Pitting, corrosion, fracture and other defects of interior walls can be continuously recorded with full-dimensional accuracy . . . of exceptional value in quality control operations.



The secret of our insight: A highly precise 45° mirror (A), mounted on a reed (B), is inserted in one end of the channel. A beam splitter (C) directs a powerful light into the channel from the opposite end which is reflected by the mirror onto the sidewall. The photographic leg of the system receives the image from the channel mirror and through the beam splitter. A camera objective (D) focuses the image on the film. The channel is advanced by a carriage in precise synchronization with the advance of film. Result: a continuous, clear photographic record of the entire channel.

Various modifications of this device have been applied to channels up to six feet long. For longer and wider channels we have designed a miniature self-propelled camera, mirror and light source capable of presenting a continuous image on film with resolution sufficient to reveal scratches and hair-line cracks smaller than .010 inch.

If you need special insight on "inaccessible" interiors, or information on other unusual applications of optics/electronics/mechanics—let's talk it over.

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the earth and radio emission from Jupiter.

• **Magnetic field**—A detailed study of Jupiter's magnetic field and its variations may explain many of the features on the planet that are puzzling the astronomers.

The magnetic field probably has a magnetohydrodynamic origin similar to that of the earth. If, however, it is due to a metallic hydrogen core, it could be much more complex because of the lower viscosity and higher turbulence.

The extreme high radio noise intensities observed are very likely the interaction of solar particles and the magnetic field. But in order to account for the intensity peaks and variations of the radio noise and the wavelengths emitted, it is necessary to postulate a very intense magnetic dipole field whose axis and center do not coincide with the axis of rotation and the geometric center. The various spots that are sources of radio noise may be interactions of the Jovian Van Allen Belt with the upper atmosphere—the spots being indications of local variations in the magnetic field which allow the particles to spiral down into the atmosphere instead of being reflected.

The unusual behavior between the South Tropical Disturbance and the Red Spot might also be explained by magnetic interactions.

• **Unmanned probes**—We will definitely want to send probes down into Jupiter's atmosphere to measure the pressure, temperature, magnetic field and composition of the various layers, bands and spots.

The major problem in the instrumentation would be the high pressures involved. The entire probe, including all instrumentation and telemetering equipment, would have to be a continuous piece of matter with no moving parts (the ultimate in solid-state engineering) or else all internal voids must be connected to the external environment so that the pressure can be equalized on the way down (the leaky sieve concept). Even these methods have limitations, since the pressure might get high enough to cause some metals to flow.

• **When do we go?**—The measurements made of the Jovian system will be important to the research scientists seeking to understand the behavior of the solar system, because Jupiter differs radically from the inner planets, both in composition and structure. But more important, these preliminary measurements will be necessary for the design of the later unmanned spacecraft that will penetrate Jupiter's atmosphere and investigate and land on the satellites.

These unmanned probes, especially the first ones, will probably travel on low-energy orbits. Using the minimum-energy orbit will require 33 months for a one-way trip. If we could get a 1-megawatt power source and a specific power of 0.2 kw/kg then we could put very large probes in an orbit about Jupiter in half that time.

But before man goes to Jupiter (or for that matter, any of the outer planets) it will be necessary to completely re-evaluate the concepts that we have been using in space travel.

Space travel with transit time counted in years, with power and propulsion units operating continuously, will require completely new concepts in equipment reliability.

Before man can go, we will need much larger power sources capable of many megawatts output. Nuclear power is the obvious solution and fortunately the specific power goes up as the absolute power is increased. As we get up to specific powers of 1 kw/kg, we can expect transit time of 1 year or less.

When do we go? Usually long-range scientific estimates in this field prove to be conservative. However, I would estimate that man will be on the way to Callisto and points down in 1985. ⌗

Jupiter and Larger Satellites

	Jupiter	Io	Europa	Ganymede	Callisto
Orbital radius (km)	7.78×10^8	4.22×10^5	6.71×10^5	1.07×10^6	1.88×10^6
Period (days)	4329	1.77	3.55	7.15	16.7
Rotation (days)	.414	1.77	3.55	7.15	16.7
Radius (km)	71400	1660	1440	2470	2340
Mass (kg)	1.9×10^{27}	8×10^{22}	5×10^{22}	15×10^{22}	9.0×10^{22}
Density (gm/cm^3)	1.33	4.4	3.9	2.4	1.7
Surface Gravity (cm/sec^2)	2600	190	150	170	110
Escape Velocity (km/sec)	61	2.5 + 25	2.0 + 20	3.0 + 14	2.0 + 12
Orbital Velocity (km/sec)	42.5	1.7	1.5	2.0	1.5

Circle No. 7 on Subscriber Service Card

DOD Zeroes in on R-F Interference

AFSC provides management, Armour runs analysis center in unified drive for vital compatibility data

by Charles D. LaFond

ANNAPOLIS, MD.—The Defense Department is mounting a direct attack on steadily worsening military-systems breakdowns caused by inadvertent r-f interference.

A single agency—the Air Force Systems Command—is managing the program; there is a single Electromagnetic Compatibility Analysis Center operated by Armour Research Foundation. The three military services are contributing data in an effort to come up with some answers quickly.

The revitalized Electromagnetic Compatibility Program got underway last summer. The new Analysis Center here is now almost fully staffed and by the end of next year its computer facility will be in operation. First output from the Center is expected this month.

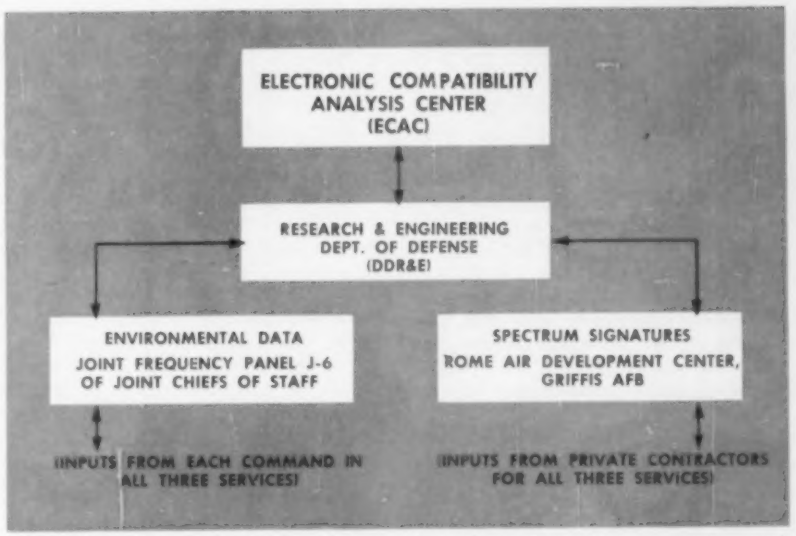
An annoyance in the past, r-f interference today is serious business. Without a better understanding of the problem, satisfactory frequency allocation will be impossible. Improvements in design can only be attained when clearcut technical direction is available.

Already, missile failures, communications jamming, radar blanking and other catastrophic failures have been recorded and later traced directly to unintentional r-f interference.

As the number, power, and sensitivity of electronic systems increase, so does the compability problem.

While early emphasis in the program will be toward alleviating existing RFI problems, the program eventually will turn toward improvements in equipment design and development.

How important is this? Dr. J. H. Vogelman, noted RFI prediction pioneer and former Director of Communications at the AF Rome Air Development Center, recently stated: "RFI might well cost us much more than the opportunity of being first with a man on the moon. It could cause us to lag perennially behind the other world powers in the rocket and missile field for years to come."


ELECTRONIC COMPATIBILITY ANALYSIS CENTER (ECAC)
RESEARCH & ENGINEERING DEPT. OF DEFENSE (DDR&E)
ENVIRONMENTAL DATA
JOINT FREQUENCY PANEL J-6 OF JOINT CHIEFS OF STAFF
SPECTRUM SIGNATURES
ROME AIR DEVELOPMENT CENTER, GRIFFIS AFB
(INPUTS FROM EACH COMMAND IN ALL THREE SERVICES)
(INPUTS FROM PRIVATE CONTRACTORS FOR ALL THREE SERVICES)

INFORMATION FLOW for the Electromagnetic Compatibility Program. Policy guidance is provided by DDR&E, coordinated with the Joint Chiefs of Staff. The Air Force Systems Command, Andrews AFB, Md., is responsible for establishment and direction of ECAC; Armour Research Foundation is the prime contractor.

Speaking before a New York meeting of the Institute of Radio Engineers, the Capehart Corporation scientist stressed the great need for solving RFI problems in missile/space hardware before designs leave the drawing boards.

• **Rebirth of a program**—The present Electromagnetic Compability Program was initiated at the request of Acting Defense Secretary James H. Douglas in July, 1960.

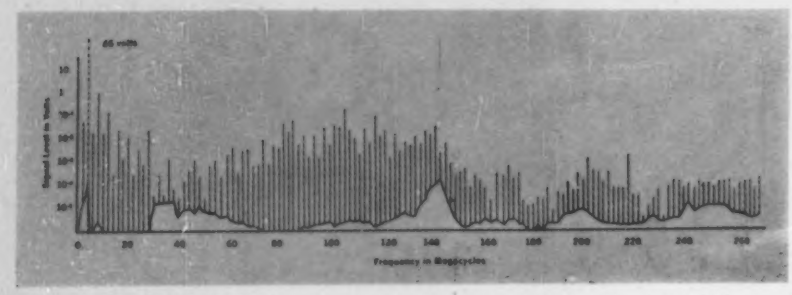
By late September, 1961, a basic program was conceived which was designed to prevent the creation of another many-headed and ineffectual monster. Deputy Defense Secretary Roswell L. Gilpatric issued a promulgating memorandum requesting that the Chairman of the Joint Chiefs of Staff and the Director of Defense Research and Engineering each designate a representative to establish and carry out jointly the Compatibility Program as requested by Secretary Douglas.

Further, it was stated that the tri-service program would be subject to the authority, direction, and control of the Secretary of Defense.

To bypass troubles encountered in earlier programs also aimed at the solution of radio-frequency interference problems, a single analysis center was deemed necessary to process effectively all data collected by each of the three military services.

Finally, Gilpatric's memo made the Air Force responsible for establishment of such a center and for directing its activities in accordance with policy directives of the JCS and DDR&E representatives.

Those close to the problem over the past 10 years are in accord with the belief that the DOD decision to truly unify the three-service effort in



UNDESIRED RADIATION from a typical radio transmitter is plotted by signal intensity on this Armour graph. Assigned transmitter frequency was 4 mc (dotted line), but note the wide range of spurious emissions recorded.

RFI control is not only a most significant move but possibly the only approach to an effective program.

• **New analysis center**—The central data collection and processing facility is located here at the U.S. Naval Engineering Station.

Armour Research Foundation was awarded an 18-month, $2 million contract last summer for technical operation of the Center. The contract was placed by the Electronic Systems Div., Hanscom Field, for AF Systems Command, although program control is now at AFSC, Andrews AFB, Md.

Presently staffed by 120 persons, largely scientific and technical, the group will be enlarged over the next few months to 167. Technical director over the ARF team is Stanley I. Cohn; director of the Center is Col. Charles C. Woolwine, USAF.

Under an ARF subcontract, the Engineering Experimental Station, Georgia Institute of Technology, is assisting Armour in establishing the Center.

Still to be acquired for the station is its computer facility. Cohn's group now is using the Remington-Rand Univac complex at Armour's Chicago home. Several major computers are now under study and a selection will be made shortly by Armour and the Air Force.

The new data processing equipment, furnished by the Air Force, is scheduled to be in operation by late 1962, Cohn said.

• **RFI studies**—Principal mission of the Analysis Center is to provide an analytical capability for determining radio frequency interference effects on electronic systems degradation. The team also will make recommendations to correct deficiencies in military systems to assure that their future performance will meet design requirements for environments of unintentional RFI.

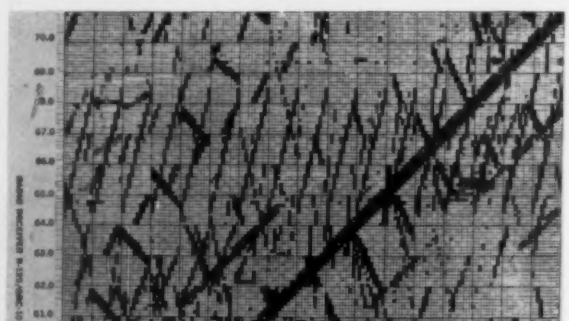
To carry out its mission, the Center will establish a "data base" to satisfy three broad objectives:

—The prediction of interference potentialities among electronics equipments under operational-environment conditions.

—The provision of a central means for improving radio-frequency management within the three military services.

—The establishment of a tri-service consulting organization for R&D programs involving electromagnetic-compatibility.

• **Radar first**—Initial emphasis, according to Cohn, will be placed on problems associated with military radar systems. Later, communications problems will be attacked.



TYPICAL MUTUAL INTERFERENCE: Blackened areas on Armour Research Foundation chart indicate frequencies at which interference will occur at the receiver for any given transmitter frequency. (Select a transmitter frequency, move across the chart, and note which frequencies correspond to the darkened areas.)

Input data to the Center will vary considerably. Basically it will consist of environmental and spectrum-signature information. Environmental data involve both military situations and the deployment of electronic equipment. Individual equipments will be studied by outside contractors to each of the services to determine electronic operating characteristics.

The center will then employ these data inputs to determine environmental interaction, frequency allocation information, operational procedures (for better compatibility) and possible interference- and susceptibility-reduction measures for offending equipment.

Cohn believes that in time this program should permit better utilization of the r-f spectrum with respect to both frequency allocation and equipment characteristics.

• **New ADP techniques**—Processing of data for electromagnetic compatibility will require new techniques, Cohn asserts.

The center will establish a vast library of data from the field and it will prepare and store the information in a form suitable for digital computation.

A continuous effort will be maintained to develop and refine computer programs for analysis. Also, operations-research methods will be developed and used for determining the best possible frequency allocations and operating procedures for enhancing compatibility.

• **Parallel studies** — The extremely complex results of analysis, Cohn pointed out, demand better handling methods. Thus, the program will require R&D in the application of data read-out systems, map printing, and environmental display techniques.

The validity of input data also must be considered, he stressed. With experience, the types and accuracy of data requirements will change. Measurement techniques in the field will have to be reviewed and revised as necessary to meet more demanding requirements.

Finally, the Center will have to keep abreast of the rapidly changing electronics art—in interference reduction and in advanced equipment designs.

The task ahead is going to be a tough one, but it will pay for itself many times over if successful. The avoidance of disaster due to ill-timed interference would be a spectacular reward for the effort. Economically, however, the payoff will be even more significant for it should permit the design of future systems for electromagnetic compatibility and avoid the necessity for correction after the fact. ⌗

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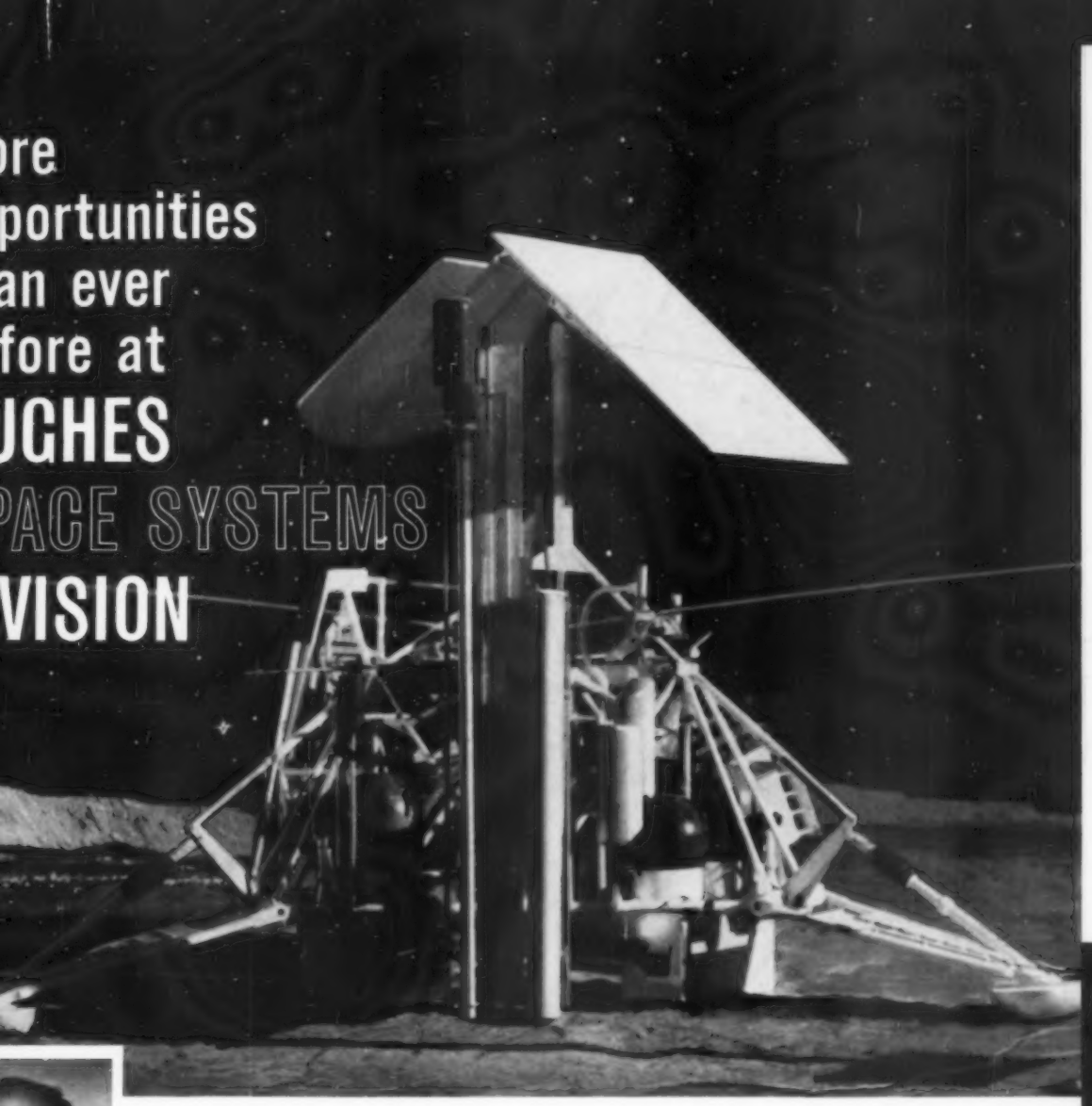

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entation Engineers

Involves the integration of advanced instruments into spacecraft such as Surveyor. Includes design for in-flight reliability; technical direction of instrument subcontractors; development of test programs and test equipment; and determining instrument interactions. Experience with subcontract procedures is also helpful.

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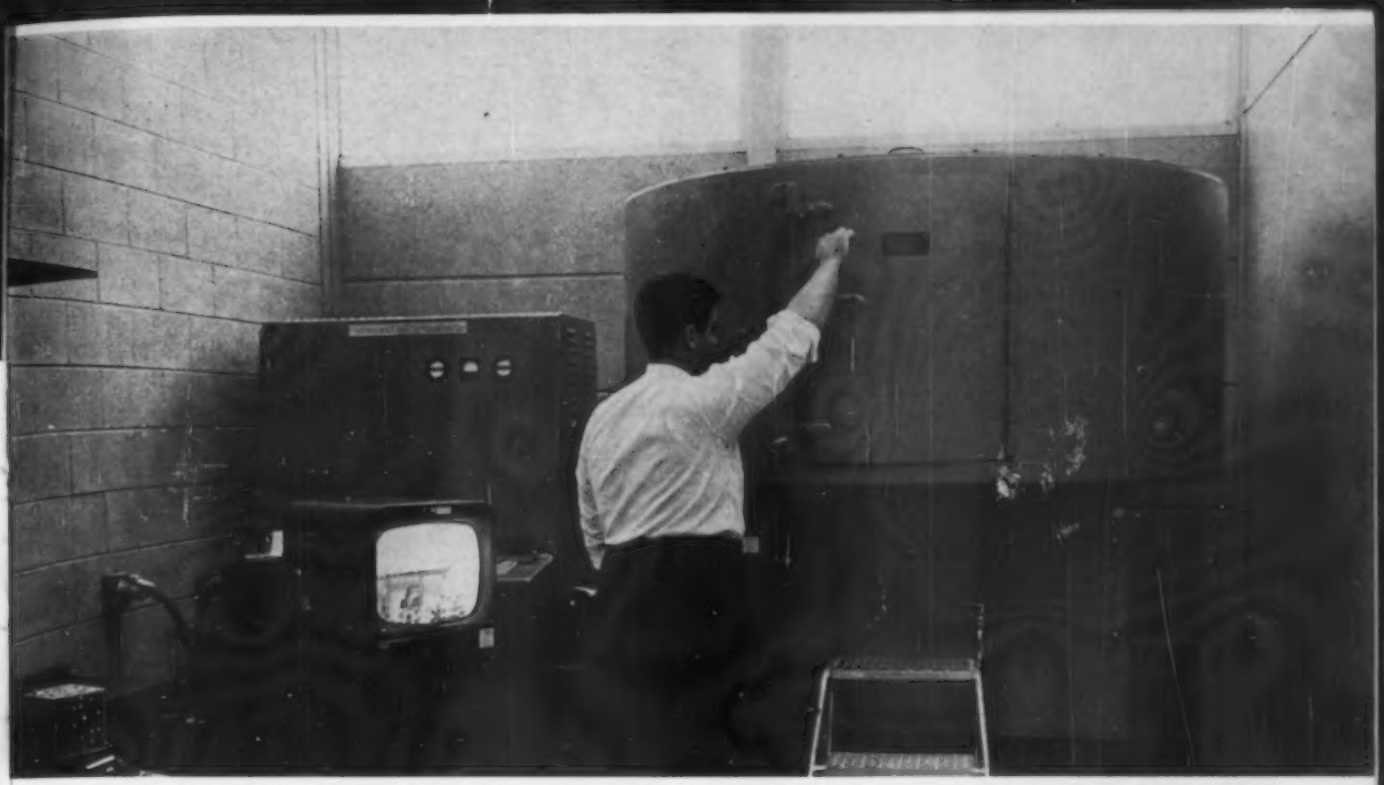


TIMER UNDERGOES acceleration in GTL centrifuge monitored by closed circuit television.

fuzing and arming

Warhead Timers Tested in Centrifuge

WARHEAD timing devices for several U.S. missile systems are undergoing severe acceleration tests in General Time Laboratories' centrifuge at Skokie, Ill.

Timers used in *Polaris, Talos, Nike-Hercules, Mauler* and *Sidewinder,* among others, are exposed to acceleration extremes up to 200 g's.

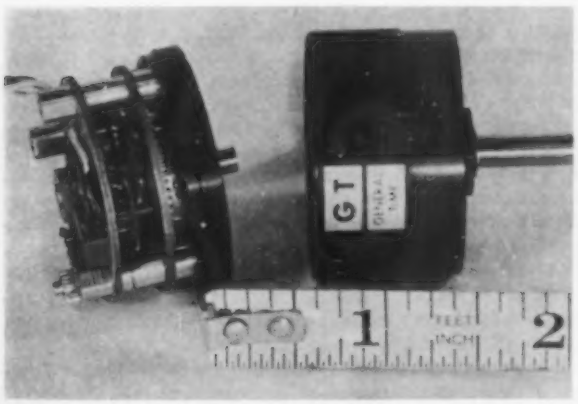
The environment effectively simulates missile launch and re-entry forces. Every timer destined for use in a warhead arming circuit is tested in the centrifuge. These timers, used primarily in ICBM systems, are set to activate the arming mechanism at predetermined g-levels.

Other timing devices, not made to activate at specific g-levels, are also tested in the centrifuge by standard production reliability testing ratios.

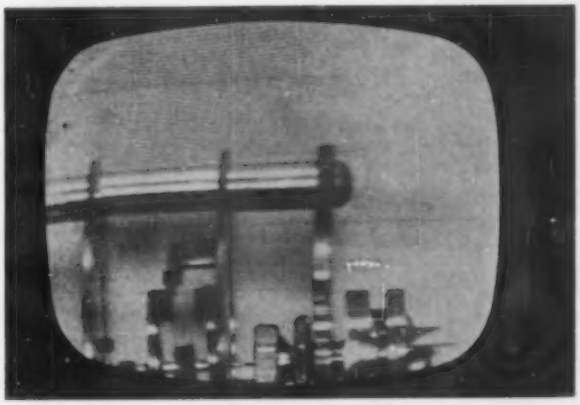
Duration of the tests can run from five minutes to one-half hour, depending upon which missile the unit is going into. Time needed for the centrifuge to reach peak acceleration speeds is not a factor, since the GTL unit moves from a stand-still to 140 g's in 10 seconds.

Monitoring of component behavior within the timer is accomplished through a closed-circuit TV installed within the centrifuge. A magnification device within the test setup enlarges the ¾-in. timer to fill a 20-in. TV screen.

GTL is developing additional space applications for these highly sensitive timing devices. Activation of specific systems within a manned space vehicle during periods of high crew stress could be accomplished with timers of this type. ■



TYPICAL TIMING DEVICE tested by GTL for missile makers.

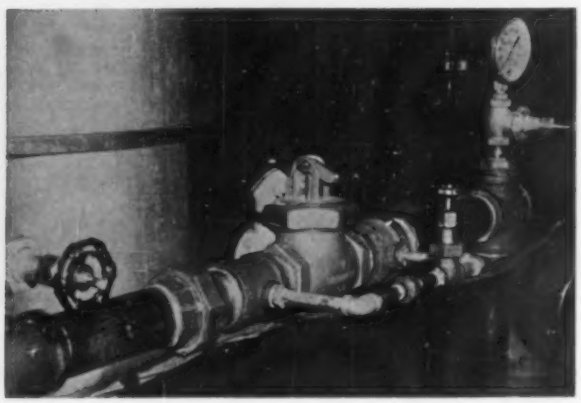


MAGNIFICATION device fills 20-in. screen with tiny unit.

Quick-Acting Fire Fighter Perfected

Grinnell system responds in milliseconds to fires in propellant processing plants; devices sense characteristic light

PRIMAC CONTROL panel houses equipment for testing system integrity without operating extinguishing phases.



EXPLOSIVELY ACTUATED valve in fired position. Latch holds piston closed; in operation, primer rests against latch.

A FIRE CONTROL system for propellant processing facilities—with millisecond response time between detection and douse—has been developed by engineers at the Grinnell Co., Inc.

Although much of the work in ultra-high-speed fire protection has been done in connection with solid propellants, the principles involved and the system components can be used for any hazard requiring extreme operational speed, says C. F. Averill, manager, Special Hazards Dept.

Grinnell engineers tackled the two main phases of increasing the speed of a fire protection system—detection time and getting the extinguishing agent to the burning surface as fast as possible.

Conventional fire detection equipment depends on heat, smoke or some other product of the combustion. Grinnell took the one evidence of fire always present with high-energy fuels—light. The actuation system operates with a photo-sensitive cell.

• **Choosey cells**—Since many forms of light are normally present, the system had to be given built-in discrimination capability. Grinnell's Primac system uses a solid-state photo-sensitive cell limited to the infrared band of the spectrum.

In addition, the cell is mounted so that its field of view is directional. The detection equipment is designed to operate only when the cell "sees" light above a certain intensity, making it possible to override ambient light conditions.

Averill says the detectors are usually arranged to operate in pairs and both must function before the system will operate. Ideally, each pair should be mounted opposite each other, preventing operation from reflections, flashlights and other normal sources.

The detector signal is carried to a solid-state amplifier in the control panel, which actuates the extinguishing section of the system. The panel can also test the integrity of the system without activating it.

Bringing the extinguishing agent to the fire necessitated the development of a fast-acting valve. In the case of solid propellants, water is used and Grinnell engineers perfected an explosively actuated unit. The valve body is designed to accommodate a piston-type closure. This piston is held in the closed position against water pressure by a latch resting on the piston stem. An explosive primer nestles next to the latch.

Firing the primer forces the latch off the stem, allowing the piston to rise and the valve to open. Since the supply and priming water fill all cavities of the valve, the first motion of the piston starts the water in motion. Action is almost instantaneous.

• **Modified deluge**—Hazards requiring this type of quick-response protection also demand high water application per square foot for control and extinguishment. The entire hazard area should be flooded at one time. Normal systems usually employ open nozzles and empty piping leading to a deluge valve in the main supply. Filling these empty pipes in a fast system takes too much time.

Grinnell utilizes available spray nozzles with fitted caps, capable of holding priming water under a gravity head. The caps are blown off when line pressure is released into the system by the Primac valve.

While the Primac system can operate in the millisecond range, Averill says this can vary from installation to installation because of available water pressure, configuration of the piping and other normal factors. But experience gained during development work and current installations make possible the calculation of the operation time within reasonable limits.

The Primac system can handle auxiliary functions, initiating such processes as machine stoppage, fan and conveyor shutdown and sending alarms. The system can be integrated with an operation or process so that it is in or out of service as required. ⌗

Small Firms Sell 1/3 of Electronics

Stress on innovation and specialized, non-consumer products maintains share of market despite handicaps

A FRESH LOOK at the electronics industry finds small firms prospering in today's market alongside several giant companies. The key to success: be unique.

Stanford Research Institute, in a survey conducted for the Small Business Administration, reports that companies with annual sales of less than $10 million now have aggregate sales of some $5 billion—one-third of the total market. (SRI estimates sales in 1960 for all electronic products, including intracompany and intercompany sales of subassemblies and components for remanufacture, at $15 billion; it estimates that actual industry output was $10 billion.)

• **Off-beat accent**—Small firms are scoring heavily by concentrating on products with limited or underdeveloped markets.

Microwave devices and electronic test equipment are two areas in which smaller producers have been remarkably successful in meeting competition of much larger companies.

Most attractive marketing areas for small electronics firms are in the military and industrial segments of the industry, and in technologically specialized components.

For the military, there is a rapidly growing equipment market in reconnaissance and surveillance, countermeasures, checkout, detection, tracking and data reduction.

In the industrial market, small firms have been most successful in manufacture of testing and measuring instruments small in size and high in technical complexity.

The SRI study points out that innovation is vital for small electronic firms.

Because most electronic items are produced in relatively small quantities, expensive, automated equipment is less important than it is in other industries. SRI says the correspondingly lower capital requirements make it possible for small firms, starting on small budgets, to compete effectively with industry giants. Highly skilled labor, for both design and production—not large and expensive plants—is the key commodity in all electronics manufacture.

• **Still tough**—The study does not minimize the problems of small companies in trying to compete across the board with larger firms.

In most instances, small firms are able to compete on a basis of quality or uniqueness of product rather than price. This, however, requires a high investment in company-funded R&D. Also, SRI reports, it often means staying out of price-conscious consumer markets.

Development of effective management is another problem for smaller companies, which cannot in general afford to retain the management specialists who serve larger organizations. Often, the highly trained technical person who starts a new business has only marginal experience in the economic aspects of business operations. This problem becomes acute as a company begins to experience the high growth rate typical of many organizations in the industry.

Still another headache may develop in raising capital. Successful small electronics firms often grow so rapidly that all of their funds are tied up in inventories and accounts receivable. At this stage of development, financial experience is invaluable for providing capital for further expansion.

SRI underlines the industry's increasing complexity as one of the negative factors for the future. On the positive side, investor interest in electronic firms has made it less difficult to raise capital than in the past. In addition, the industry has not changed basically and is, for the most part, still conducive to small quantity production, with relatively simple equipment, in small non-integrated facilities.

The SBA has found data on the electronics industry very scarce despite the industry's tremendous growth. It sponsored the SRI study in an effort to establish new programs which would aid small business men in filling and expanding their role in the nation's economy. ⁂

Rings for the Minuteman

MACHINIST at Ryan Aeronautical Co. operates one of nine big turret lathes used to machine separation rings for AF's Minuteman solid-fueled ICBM. Ryan's San Diego plant is producing the rings in large quantities, made of aluminum alloy and ranging from 37½ to 65 in. in diameter, under subcontract to Boeing, Minuteman prime contractor.

Award spells $1-2 billion in sales by 1965 . . .

(Continued from page 15)

Storms said only a small amount of outside recruiting will be necessary in assembling the technical staff for the project. Employment at the division now stands at about 7800. This is expected to expand only slightly.

• **X-15 lessons**—When Storms moved into the presidency of the division in December, 1960, he took with him a good portion of the team which engineered and built the *X-15*. More members of this team will be shifted to Downey as the *X-15* phases out and *Apollo* phases in.

Storms believes that the experience of the *X-15* team—which he describes as "a real gung-ho outfit"—was one of the major factors in North American's winning of the award.

"They've been through this once," he said. "They know what to look for and are well-seasoned." The division president pointed out that the designers and engineers on the *X-15* project have worked together nearly 10 years and that many of them have been with North American as long as 20 years.

"We don't have to go out and recruit 500 engineers off the street who have never seen each other," he said.

Much of the remainder of the NAA team being assembled for the *Apollo* project will come from other North American divisions. Structures people are being shifted from the Los Angeles division and a number of high-caliber personnel already have been transferred from the Rocketdyne division.

• **Managers**—The NAA team will be headed by John W. Paup as project manager. Paup will be in complete charge of the program, Storms said.

"He will not be an adviser or a staff official but a line officer," Storms said. "He will give orders, not suggestions."

Paup, formerly an Air Force colonel in electronic countermeasures, worked as electronics manager on the B-70 at North American's Los Angeles division. He left to join Sperry-Utah at Salt Lake City and then rejoined NAA to work on the *Apollo* proposal.

Assistant to Paup will be former West Pointer Milton Sherman, who has been with the Downey division for some time.

Chief engineer on the North American *Apollo* project will be Charles Feltz, former project engineer on the *X-15*.

"It will take a little while to get everybody in place," Storms said, "but the team should be nailed down by the first of the year."

Asked how North American planned to tackle management of the prime contract in the manned lunar landing program, Storms reply was typically brief: "Just professionally."

Details of the management and subcontracting will be worked out with NASA in the talks which will begin this week. These are expected to take place both in Washington and on the West Coast.

"Before, we were suggesting to them," Storms said. "Now they are going to tell us what they want."

• **Them as has . . .** —The award to NAA came in the face of the fact that North American already stands in first place as NASA's largest industrial contractor. It is third on the Department of Defense military contracting list.

The Space and Information Systems Division itself accounted for more than 9% of NAA's record $1,262,333,263 in sales in Fiscal 1961, which ended Sept. 30. Division sales of $108,144,000 were up from the Fiscal 1960 sales figure of $82,081,000.

North American's overall net earnings were $27,750,137 for the fiscal year, up from $23,394,548 in Fiscal '60. Non-aircraft programs accounted for some 62% of the total sales in Fiscal '61.

The award is expected to pour between $1 billion and $2 billion in sales into North American over the next five years.

• **Schedule set**—Space agency officials declared that final design of the spacecraft will be determined in six months, with production to begin in eight to twelve months. The first representative spacecraft will roll off the assembly in 1964 and be sent on earth orbital missions late in that year.

That schedule, the official said, will be ready for manned lunar landing in 1967.

This and other new information on the spacecraft's systems and configuration were revealed shortly after NASA announced the selection of NAA to head its industrial team.

Initial phase of the contract will be worth $400 million, but estimates of the total cost of the spacecraft program run from $10 billion to $15 billion.

The contract—to be signed before the end of the year—will also set the specifications for the lunar landing module and orbiting laboratory modules.

Massachusetts Institute of Technology Instrumentation Laboratory has already been selected as the associate contractor for the spacecraft's guidance and control system. An industrial firm will be selected by NASA to produce the systems.

• **Rough shape**—NASA officials refused to disclose specific figures on the spacecraft's weight or dimensions. They declared that this information is classified and its disclosure would provide the Soviet Union with key facts about the state of U.S. space technology.

One official said, however, that the spacecraft will weigh between 100,000 and 150,000 lbs. It will be 15 ft. to 20 ft. high and about 60 ft. long. Its command and service modules will be about 12 ft. to 15 ft. in length and diameter. The lunar landing (Propulsion) and orbiting laboratory modules will be about 30 ft. long.

Other important information revealed includes:

—Materials: A plastic ablation material (like fibreglass) will be applied over a double-shell honeycomb-type of structure which will be constructed of either aluminum or stainless steel. The structure will be a monocoque type which does not rely on internal pressurization to sustain itself.

—Propulsion: The lunar landing module will have to have a capability of 50,000 to 75,000 lbs. in terms of thrust. It will be powered by hydrogen/oxygen and require throttling capability. Thrust vector control will also be needed.

NASA has chosen to use multiple engines—several large ones with fixed thrust and smaller ones with variable thrust.

The smaller engines will take care of the terminal phase of the lunar landing, and will be throttleable from plus or minus 1/6 of the spacecraft's weight at lunar touchdown.

The lunar landing module must also be capable of hovering and moving laterally.

—Abort and lunar takeoff propulsion: An earth-storable hypergolic system similar to the current *Agena* launch vehicle will be used. It will also need small propulsion for attitude control, which will also use storable hypergolic with about 25 lbs. thrust.

—Power: Current plans are to use hydrogen/oxygen fuel cells. Because of the time factor, chemical batteries will be used in the early earth orbital flights.

—Guidance and control: These are being developed by MIT. It is certain, however, that a lightweight computer, a stabilized platform, and an integrated accelerometer are required. ⁂

The First OAO

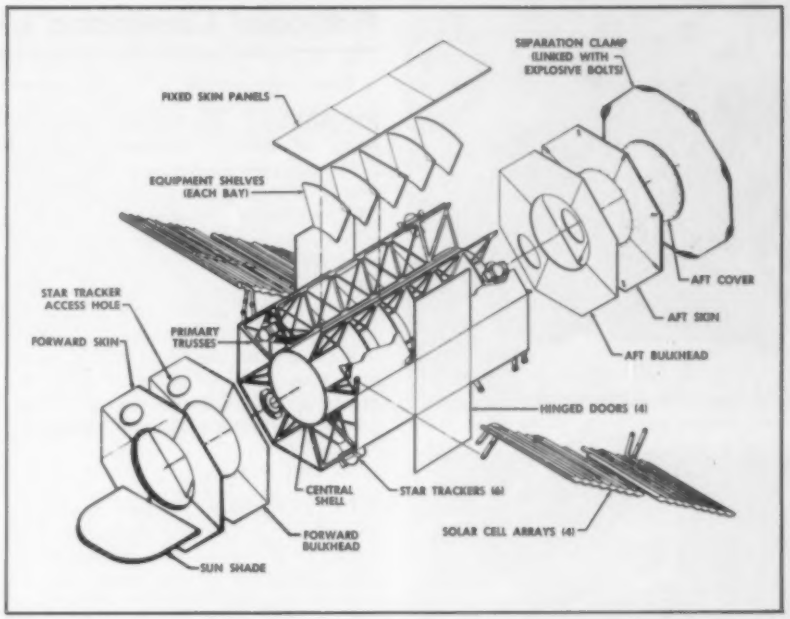
(Continued from page 17)

gular momentum transfer from the vehicle to the wheels. Two unloading systems are employed with the OAO to prevent wheel rotation rates from becoming excessive.

The first method employs gas jets arranged so that a torque will be provided about the proper control axis when any of the wheels reach a threshold speed. This will serve to reduce wheel speed to below pre-set limits.

The second system available will employ magnetic unloading to acquire the necessary torque effect. This is the first known application of this principle to actual satellite operation. The torque will be provided as a result of the interaction between the earth's magnetic field and current carrying coils mounted in the vehicle.

This system promises high reliability since no moving parts are required and also has the distinct advantage of continuous reduction of the angular momentum of the wheels.



BASIC OAO STRUCTURE was designed to provide craft easily adaptable to future scientific missions and capable of housing an assortment of instruments.

• **Design objective** — The guiding objective behind the design for OAO was the creation of a standardized spacecraft capable of mounting one or more separate astronomical experiments and easily reconfigured to meet changing scientific needs.

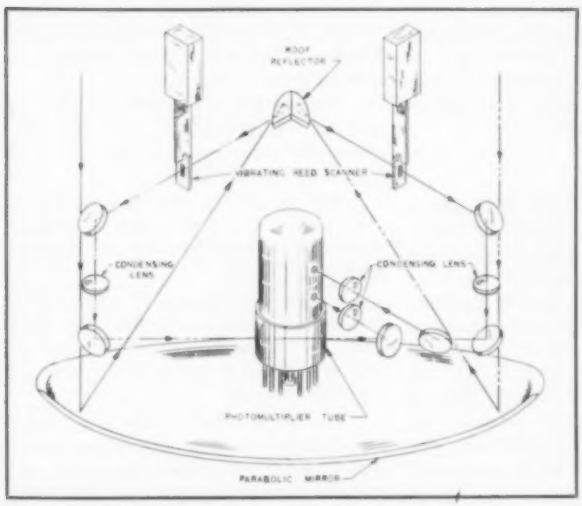
The OAO's eight-sided shell, measuring 116 in. long and 80 in. wide, contains a hollow shaft longitudinally through its center for insertion of mirror devices with up to 40-in. diameters.

The structure has been designed for extreme rigidity and minimum thermal distortions in order to maintain the precise orbital alignment requirement for performance of its mission. Aluminum is used as the basic structural material, but several key components are mounted with titanium.

Primary power supply for the OAO is generated by a fixed array of silicon solar-cells mounted in a saw-tooth pattern on two paddle-like structures attached to two sides of the satellite. These paddles are folded along the sides during launch and erect to in-flight position after booster burn-out.

Four r-f links are available for OAO tracking, radio command, and telemetering purposes.

Two of the links are for telemetry use, a wide-band net for transmission of analog and digital data at rates up to 50,000 bits per sec, and a narrow-band link for handling other digital information at speeds up to 1000 bits per sec.



OPTICAL SYSTEM for the six star-trackers deployed around the OAO shell is shown in this schematic.

Radiation patterns for the various communications systems are designed to provide as much spherical coverage as is possible in order to maintain favorable communications with ground stations despite satellite orientation.

Programed commands to OAO will originate from a central control facility at the Goddard Space Flight Center in Maryland and will be broadcast via specially equipped Minitrack stations.

Another major feature of the OAO is its ability to react to ground commands both to the experimental package and to the spacecraft. An OAO control center receives coded ground signals, decodes, and distributes the message to the proper system within the observatory. Delayed commands can be stored within the unit's command storage area until the correct elapsed time.

A magnetic-core type data storage facility with a 100,000 bit capacity is also provided for storage of data on experiment and spacecraft status which is periodically transmitted to earth, and also for data accumulated while the satellite is out of line-of-sight range with ground stations. (M/R, June 12, p. 26). These commands can serve to activate a number of OAO systems and also act to reorient the spacecraft.

Major subcontractors teamed with Grumman in OAO effort include General Electric's Missile & Space Vehicle Division, IBM's Space Guidance Center, and the Westinghouse Air Arm Division. GE is providing several stabilization and control components and subsystems.

Kollsman Instrument Co. has been subcontracted by GE to produce the star trackers, and Ball Bros. will turn out the solar trackers. IBM is supplying the OAO control center and most of the data storage and processing subsystems. WEC is designing and manufacturing the special ground operations equipment for the three minitrack stations and ground control station. ⌗

National Command and Control System

(Continued from page 13)

PRESIDENT C. W. Halligan, *former Director of Military Engineering at Bell Telephone Laboratories, was named president of Mitre when it was set up in 1958. The 59-year-old executive had been associated with a wide variety of programs at AT&T, Western Electric and BTL since 1926. These included SAGE, the DEW Line, and early development of U.S. air warning systems. Halligan holds 12 patents in the communications field. He was graduated from Bucknell in 1923, received a Master of Science degree there and taught at the Bucknell College of Engineering.*

VICE PRESIDENT Robert R. Everett *joined Mitre as Technical Director in 1958, moved up to become Vice President-Technical Operations a year later. The 40-year-old electrical engineer became associated with the pioneer Project Whirlwind computer program two years after receiving a Master of Science degree from MIT. He received his bachelor's degree from Duke. In 1951, Everett became associate director of the MIT Computer Laboratory, then moved with the organization when it became part of Lincoln Laboratory. In 1956, he became head of Lincoln's Division 6, which designed the SAGE system.*

ASSISTANT VICE PRESIDENT John F. Jacobs, *formerly Mitre's Systems Technical Director, was named Assistant Vice President in October. Jacobs joined Mitre in 1958 after spending six years at MIT working on system engineering for air defense projects. In 1955, he headed a project group at Lincoln Laboratory; later he became an assistant division head, then an associate division head. During this period, he served as a liaison engineer with industry for SAGE. Jacobs, who is 38, was graduated from Illinois Institute of Technology in 1950. He received a Master of Science degree from MIT in 1952.*

SYSTEMS PLANNING AND RESEARCH DIRECTOR Charles A. Zraket *moved to Mitre in 1958 after working for five years at MIT's Lincoln Laboratory primarily on SAGE. He was a Section and an Associate Leader in the design and development of SAGE and later headed the Advanced SAGE Program Development Group. He was Mitre's Associate Technical Director for Command and Control Systems until last month, when his new Directorate was established. Zraket, who is 37, was graduated from Northeastern in 1951. He received a Master of Science degree from MIT in 1953.*

gramed long in advance and other vastly complicated electronic systems are needed.

However, the Air Force lacks a sufficient supply of highly competent electronics experts to provide itself with objective technical support in this field. Its answer to the problem is Mitre.

• **"A little bit more . . ."** — This answer is sharply questioned and resented in many sectors of private industry. Congress, in turn, has reflected this reaction.

Halligan and many Air Force officials feel that this reaction comes from misunderstanding the role of Mitre. It may also be based in some cases on being thwarted in establishing a design requirements for one's own hardware.

"The only thing we take away from private industry," Halligan said a few days ago while sitting in his Mitre office at Bedford, Mass., "is the part of the job where objectivity and its relationship to all other systems is important.

"Most reasonable people see this. A lot of industry officials drop by to talk to me about one thing or another, and sooner or later they ask: "What are you going to do to us?" And, invariably, they go away very much relaxed."

Halligan grinned and took a sip of coffee from a cardboard cup. He was in his shirtsleeves and he talked with the informal air of the scientist-administrator.

"To make these systems succeed," he said, "you must have one boss, one central point of control. That is ESD. But they must have one technical source of advice to assist them in arbitrating technical questions between two contractors.

"But, if ESD is to rely on this one source, this means he must be damn good. He must know a little bit more than anyone else."

The Air Force sees Mitre's role in very much the same way. It regards Mitre as a key part of its in-house capability.

• **Sharp changes** — Together ESD and Mitre in the last several years have radically changed much of the Air Force's thinking about command and control systems.

The pivotal factor, the significance of which has become increasingly clear, the type of electronic command and control system installed greatly determines what kind of war can be fought.

National policy—the planned mili-

tary job—is built into the system. Therefore, a definition of the military job must precede the system rather than the other way around, as has been done many times in the past.

The systems that exist today are first class examples of the problem:

Communications and command posts are generally vulnerable. Computers are generally programed to cope with a retaliatory strike. The ability to maintain overall command from the top for any length of time that can be measured in more than hours is in doubt.

This system—or, more accurately, the group of not necessarily integrated systems—is designed to commit U.S. strategic forces in a reflex strike in accordance with the national policies of the 1950's. This group of systems was not designed to fight a nuclear war over a long period of time, to cope with the unexpected, to be ready to fight the various possible wars now envisaged by some planners in the Kennedy Administration.

• **Spelled out**—Discussing some of the current problems and needs of command systems, John F. Jacobs, Mitre assistant vice president for technical operations said recently:

—A single, continuous operational line of command from the highest level of national authority to any weapon is essential. There must also be an emergency political line of succession to assure survival of national decision-making capability. Furthermore the people in the emergency line of succession must be thoroughly familiar with the war plans and procedure and be in contact with their military counterparts.

—The military system must be capable of selective and deliberate response to attack—a response not solely dependent on warning. There must be rapid but considered decision-making capability and rapid execution of decisions. This requires pertinent situation assessment data, data processing and reliable communications.

—The national decision-making apparatus must have a survivable trans-attack capability. There must be continuous manning of primary and alternate centers to assure the smooth transition from pre-attack to trans-attack to the post-attack phase of war.

—The top command must be able to maintain a continuous view of both the enemy and U.S. forces. And at least some sensors and communications to forces must be able to survive repeated attacks.

• **Evolutionary** — Many of these requirements already are being applied in designing the Air Force's new command and control systems.

However, the approach that is being taken is evolutionary rather than revolutionary.

"Our goal," Halligan has said, "is to begin with what the military has and give them over a period of years what it needs. This is far better than giving the military nothing new for five years then dumping something in its lap that no one knows how to operate."

By taking this approach, there are also the advantages of achieving growth through experience with new equipment and of being able to introduce new requirements in line with developing policies.

The very meaning of "L" system is changing.

"In the beginning these things were pretty well separate," an Air Force official said recently. "They grew like Topsy. But now the "L" system is only a convenient package, a management device for handling an integrated part of the whole which is steadily evolving."

But even with the evolutionary approach the difficulties in devising the electronic command and control systems needed are tremendous.

As Zraket explained it candidly:

"With a manual system a commander could change what he was going to do day to day. With the electronic systems, we have in the past tried to define two to five years ahead of time how you are going to fight a war in explicit detail.

"The problem is you really can't do this. We need something much better." ⌘

Command and Control Systems

Command Systems

425L—NORAD COMBAT OPERATIONS CENTER: A system which collects, processes, and displays data to assist the Commander in Chief, North American Air Defense Command (NORAD) in commanding and controlling his forces. Prime contractor—Burroughs. Status—under implementation.

465L—STRATEGIC AIR COMMAND AND CONTROL SYSTEM: A system which collects, processes, and displays data to assist the Commander in Chief, Strategic Air Command (SAC) in commanding and controlling his forces. Prime contractor—IT&T. Status—development.

473L—AIR FORCE CONTROL SYSTEM: A data processing and display system to assist USAF Headquarters in making command decisions. Prime contractor—IBM. Status—design.

Control Systems

416L—SAGE AIR DEFENSE SYSTEM: A semi-automatic area air weapons control and warning system for detecting, indentifying, tracking, and providing weapon intercept control capability against air-breathing missiles and aircraft attacking North America. Systems management—Western Electric. Status—under implementation.

412L—AIR WEAPONS CONTROL SYSTEM: An overseas theater tactical air weapons control and warning system. Prime contractor—GE. Status—development and production.

431L—TRAFFIC CONTROL AND LANDING SYSTEMS: A program to develop and produce air traffic control equipment—landing and terminal systems—essential to the Air Force. Status—under implementation.

Intelligence Systems

438L—INTELLIGENCE DATA-HANDLING SYSTEM: A system for high-speed processing of world-wide intelligence data. Prime contractor—IBM. Status—active.

466L—ELECTROMAGNETIC INTELLIGENCE SYSTEM: A world-wide system for collecting intelligence by electromagnetic means and processing for transmission to users. Prime contractors for study—RCA/IBM. Status—study and preliminary design.

Warning Systems

474L—BALLISTIC MISSILE EARLY WARNING SYSTEM: A system to provide early warning of a mass ICBM attack on the North American continent from the north. Prime contractor—RCA/Western Electric. Status—under implementation.

413L—EXTENSION OF DEWLINE: A distant warning system for detecting hostile air-breathing threats approaching the North American continent from the north. Prime contractor—Western Electric. Status—under implementation.

477L—NUCLEAR DETECTION AND REPORTING SYSTEM: A system to provide NORAD and other military and civilian agencies with essential information on nuclear detonations occurring within the NORAD area of responsibility. Status—study.

496L—SPACE TRACK: A system for detecting, tracking, identifying, and cataloging orbiting objects. Prime contractor—Aeronutronic. Status—under implementation and study.

Support Systems

480L—AIR COMMUNICATIONS SYSTEM: A system to insure inter- and intra-system communications services to support global Air Force operations. Prime contractor—Communications Systems Inc. Status—study and preliminary design and implementation.

433L—WEATHER OBSERVATION AND FORECASTING SYSTEM: A global semi-automatic electronic system for observing, forecasting, and processing weather information. It is being developed in coordination with FAA and the U.S. Weather Bureau. Prime contractor—United Aircraft. Status—development.

reviews

PROJECT VANGUARD, Kurt R. Stehling, Doubleday & Co., New York, 312 pp. $4.50.

America's attempted answer to the two orbiting *Sputniks—Vanguard Test Vehicle 3*—reached its final countdown almost four years ago, on Dec. 6, 1957. In an inferno of burning propellants the vehicle toppled over, carrying a big hunk of America's scientific prestige with it.

The author tells the story behind this dismal failure—right up to the glittering success which occurred on St. Patrick's Day, 1958. As former head of Project *Vanguard* propulsion, he is able to give a first-hand account.

But the story is a far bigger one than the history of Project *Vanguard* alone. It is one familiar to every engineer who's ever had anything to do with the thousands of details that go into building a missile, and who knows how just one frozen valve, one short circuit, one erratic instrument can put millions of dollars and months of work to a fiery end.

Yet it is a story that has seldom been told nor, to my mind, told as well as it is here. **W. B.**

HANDBOOK OF ASTRONAUTICAL ENGINEERING, H. H. Koelle, Editor, McGraw-Hill Book Co., New York, 1848 pp., $27.50.

Many of us have looked forward to seeing this handbook, expecting that like others from the same publishing house, it would have inherent editorial excellence. Alas, in this instance merit seems to be skipping a generation.

Its most serious lack is in concept. Did the editors want a book that, like Marks' *Mechanical Engineers' Handbook* in its field, would be the astronautical engineer's closest professional companion? If so, why are there pages devoted to the social impact of space activities but none to mathematical tables—or for that matter, to any mathematics? And why are 12 pages used to give the full decimal classification of astronautics—which a librarian would find invaluable—while only a few words are provided on the subject of fuel cells, the hottest APU items in recent years.

An entire chapter is devoted to relativistic rocket mechanics, which has application only when a rocket's speed is a significant fraction of the speed of light; yet there is scarcely a mention of rocket packaging and transport on earth, and only a brief mention of the design of vehicles for use on the moon.

Nevertheless, the book's nearly 2000 pages contain some very good material. Among the best is the chapter on Astronavigation, which in classic handbook style gives the engineering background for a problem solution, and then proceeds to illustrate method by practical examples.

The Astrodynamics section of the book is excellent. For example, the aerodynamics portion starts with the fundamental Newtonian equations and, within the space of a few pages, carries the reader easily into the basic aerodynamics in rarefied flow. From here, the steps to "free-flight trajectories close to celestial bodies" are quickly taken but clearly marked; the data given are useful and practical—the mark of an adequate handbook.

What this critic objects to most is the insertion of material of limited engineering interest to the apparent neglect displacement of material of obvious high interest. It seems unrealistic to devote a mere 3¼ pages to conversion factors—placed at the end of the book almost as an afterthought—when these are the factors probably most frequently needed by engineers. Moreover, the editors seemingly did not even bother to update these factors from the Marks handbook from which they were extracted. There's hardly a modern conversion factor in the batch—not a mention of the astronomical unit, barns, atomic mass unit, electron-volt, roentgens; but there are conversions of barrels to gallons, U.S. gallons to imperial gallons, and long tons to kilograms.

The handbook is worth the price to those in the space and missile field. But it could have been worth much, much more.

W. B.

PROGRESS IN VERY-HIGH-PRESSURE RESEARCH, Proceedings of an International Conference held at Bolton Landing, N.Y., June, 1960, edited by F. P. Bundy, W. R. Hibbard, Jr., and H. M. Strong. John Wiley & Sons, N.Y. 314 pp.

Equipment and techniques, structures of materials formed under high pressures, and behavior of matter under high pressures are covered in the volume.

The problem of absolute-pressure calibration receives considerable attention and many interesting optical, electrical and magnetic changes in materials resulting from decrease of interatomic, or intermolecular, distances are described.

PHYSICAL CHEMISTRY IN AERODYNAMICS AND SPACE FLIGHT, Edited by A. L. Myerson and A. C. Harrison, Pergamon Press, New York, 288 pp.

Incorporates in one volume the papers presented at the Conference on Physical Chemistry in Aerodynamics and Space Flight held at the University of Pennsylvania, September, 1959. The meeting was sponsored by GE's Missile and Space Vehicle Department and the Air Force Office of Scientific Research. The papers are subdivided into sections corresponding to the original sessions and a short review of the special session discussing the status of plastic pyrolysis in ablation is included.

MEDICAL AND BIOLOGICAL ASPECTS OF THE ENERGIES OF SPACE, edited by Paul A. Campbell, Columbia University Press, New York, 491 pp., $10.

The papers in this book—written by recognized experts in their fields—delineate the energies of space, describe their potential applications, and explain their dangers for man. Among the subjects discussed are: solar and cosmic energies, magnetic fields, radiation sources within the spacecraft, gravitation, energy conversion, aspects of illumination and photosynthesis, shielding, chemical and biological protection, and biological implications of electromagnetic and particulate radiation.

This volume was conceived and developed to bring together the special knowledge of workers in the medical, biological, astrophysical and engineering sciences with respect to space energies, their conversion and use. It has been compiled from papers delivered at a symposium held late last year, sponsored by the School of Aerospace Medicine of USAF's Aerospace Medical Center at Brooks AFB, Texas. The symposium was arranged by Southwest Research Institute of San Antonio.

DIGITAL COMPUTER FUNDAMENTALS, Technical Training Department, Military Service Div., Burroughs Corp., Radnor, Pa., 520 pp., $5.50. (Checks should be made out to the Burroughs Corp. and sent to E. S. Junker, Technical Training Dept.)

This book was written as a reference for the seven-week "General Computer Fundamentals Course" given by the Military Field Service Div. of the Burroughs Corp. It is also an excellent text for the learn-it-by-yourself student.

Covering the fundamentals of electronic circuits and the logic of many different digital computers and electronic data processors, the book is designed to prepare the prospective computer technician, engineer, and programer for more advanced computer concepts. For comprehensive coverage of the many types of logical circuits used in computers, the book treats in detail five basic logic systems. These are the vacuum-tube logic system and four types of transistor logic systems: direct coupled transistor logic, resistance transistor logic, resistance capacitance transistor logic, and current mode logic.

THE ELECTRO-EROSION MACHINING OF METALS, A. L. Livshits, Butterworth, Inc. Washington, D.C., 126 pp., $5.75.

The volume covers a complete and up-to-date description of the state of the technique, technology and industrial uses of electro-erosion machining. Prime emphasis is on electro-pulse methods, which have better technical and cost characteristics and a wider field of application than the electrospark. Among the various uses of electro-pulse machining, the author describes the more thoroughly investigated copy drilling applications, which have proved the most difficult to get into operation but the most versatile in technological capabilities. There is an introduction of definitions and classifications designed to further work out the basic ideas in this electrotechnology.

PROGRESS IN POWDER METALLURGY, Volume 17, Metal Powder Industries Federation, 60 E 42nd St., N.Y. 17, N.Y. 195 pp., $12.00.

The volume covers advances in powder metallurgy application described at the 17th Annual Technical Meeting of the Metal Powder Industries Federation. A partial list of subject matter includes the manufacture of beryllium sheet from powder, high-strength sintered titanium parts, influence of fabrication techniques on electrical and magnetic properties of sintered metals and new developments in furnaces for high-temperature sintering. A special symposium covering powder metallurgy tooling and compacting techniques is also treated.

The Israel Program for Scientific Translations has recently published two technical works by Russian authors for the National Science Foundation and NASA. Both volumes are available from the Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C.

Random Processes in Electrical and Mechanical Systems, by V. L. Lebedev, deals with stationary and non-stationary random processes in linear systems, and in inertialess non-linear systems which have either one or several inputs and outputs. The application of the mathematical methods expounded is illustrated by practical examples related to various physical and engineering problems.

Non-Linear Theory of Thin Elastic Shells, by Kh. M. Mushtari and K. Z. Galimov, deals with the general theory of elastic shells under large displacements and small deformations, and with the application of the theory to the study of the stability and large deflections of parts of shell structures.

KINETICS, EQUILIBRIA AND PERFORMANCE OF HIGH-TEMPERATURE SYSTEMS: Proceedings of the First Conference, Western States Section, The Combustion Institute, Edited by G. S. Bahn and E. D. Zukoski, Butterworth, Inc., Washington, D.C., 255 pp., $12.50.

The volume is primarily aimed at those engaged in performance calculations for high-temperature systems. Subject matter includes input and output thermodynamic data per se, computer programming for output thermodynamic data and for standard engine performance parameters, combustor and exhaust nozzle design.

NON-LINEAR THEORY OF THIN ELASTIC SHELLS, Translated from the Russian by J. Morgenstern, J. J. Schorr-Kon and PST Staff. Office of Technical Services, U.S. Dept. of Commerce, Washington 25, D.C., 372 pp., $3.75.

The book deals with the general theory of elastic shells under large displacements and small deformations, and with the application of this theory to the study of stability and large deflections of parts of shell structures.

HIGH-STRENGTH STEELS FOR THE MISSILE INDUSTRY, Edited by H. T. Sumison, Lockheed Missile and Space Div. Order from the American Society for Metals, 276 pp., $12.00.

The volume includes the papers and one written discussion presented at the Golden Gate Metals Conference, February, 1961. A majority of the papers are devoted to the many aspects of solid-rocket motor chambers. Others cover fabrication problems, stress corrosion, fracture theory, metallurgical tests, a cobalt-containing high-strength steel developed by the Mellon Institute and future applications for high-strength steels.

New Way to Locate Targets

LOCKHEED'S Missile and Space Division will have in operation late this month a radio telescope employing a new method of locating airplane targets. The heavy 85-ft. parabolic dish of the new structure remains stationary, with focus achieved through movement of a small, steerable feed antenna suspended over the dish.

PLASMA ACCELERATION; The Fourth Lockheed Symposium on Magnetohydrodynamics, Edited by S. W. Kash, Stanford University Press, 117 pp., $4.25.

The author has collected a number of papers covering recent experimental and theoretical results concerning the principal means of accelerating ionized material for propulsion — including pulsed magnetic plasma accelerators and d-c electrostatic ion-electron accelerators. Various geometries are considered, as well electrodeless and crossed-field configurations. Scaling relations for devices employing fully ionized gases are derived. Detailed information is given on the problems involved and the obtainable thrust specific impulses and efficiency.

ROCKET PROPULSION TECHNOLOGY, Vol. 1. Plenum Press, Inc. New York; 370 pp., $12.50.

The book contains the proceedings of the Rocket Propulsion Symposium, held at Cranfield, England, Jan. 6-7, 1961. All papers read as well as formal discussions held are included.

Reliability and controllability in rocket engines are the chief topics dealt with. In addition, several valuable papers on other areas of rocket propulsion are presented—many describing new experimental and test techniques such as instrumentation techniques, pump efficiency measurement, solid propellant internal ballistics, packaged liquid propellants, and hydrogen as a propellant.

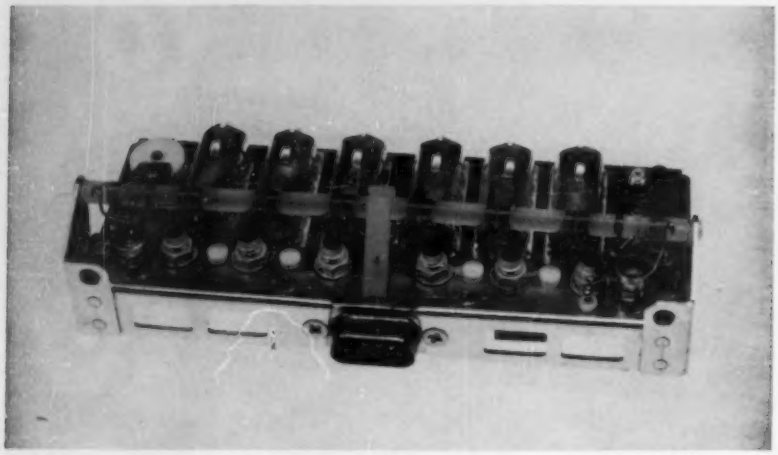
SALES MANAGER'S GUIDE TO SOUTHWESTERN BASES, compiled by the Los Angeles Chamber of Commerce. $1.50 to members of LA Chamber of Commerce, $3 to non members.

The Guide is a marketing directory to southwestern military establishments. Bases are located by operating service and every purchasing and contracting office is listed by title, location, address and phone number. Also included are suggestion on how best to approach these buying influences, and sources for additional support information on selling to the military.

HANDBOOK FOR TECHNICAL WRITERS, R. C. Tracy and H. L. Jennings, American Technical Society, Chicago. 134 pp., $3.50.

Primary attention in this handbook is directed toward report writing. Since government agencies and government contractors are the two primary sources of technical documents the book is oriented towards these organizations.

The book examines the function of report writing, then deals with elements of technical documents, technical writing style and security requirements.



New Product of the Week: Low-Cost Broadband VHF Amplifier

THE MOTOROLA INC. Systems Research Laboratory is marketing the first low-cost, MIL-E-5400 Broadband VHF Amplifier. Designated Model LPD01, the miniature amplifier weighs less than 6 oz. and occupies a space of less than 12 in.^{3}

With exceptional broadband response, the rugged unit provides 9 db gain over the entire 30 mc to 300 mc frequency range. The amplifier is designed as a plug-in module that can be readily cascaded ahead of a tuned receiver, or used as a crystal video receiver by employing a crystal detector.

Suitable pulsing of the amplifier's bias line can convert a CW signal into a pulsed RF signal, and enable RF gating or receiver blanking functions. Control of the pulse amplitude will provide variable attenuator characteristics, and instantaneous automatic gain control operation for RF limiting applications.

Circle No. 225 on Subscriber Service Card

Tiny Power Packs

Electronic Research Associates, Inc., is marketing a line of subminiature, solid-state high-voltage d-c power supplies. These exceptionally compact self-contained units provide either regulated or non-regulated high voltage outputs utilizing solid-state devices and magnetic components in special circuitry. Units utilize balance transistor keyers to convert the input power to a high-frequency source. Regulation is accomplished at low voltage levels by control of the characteristics of the transistor keyers.

Circle No. 226 on Subscriber Service Card

Silicon Controlled Rectifiers

The Industry's first Silicon Controlled Rectifier is available from Solid State Products, Inc. Packaging techniques newly developed by SSPI make this miniaturization possible with no sacrifice in sensitivity, cutoff characteristics, or inherent reliability. Two-mA triggering, d-c ratings to 200 volts and 350 mA and with pulse capability to 10 amperes are available in both conventional outline and a radically new in-line configuration for welded modules and printed circuits.

Circle No. 227 on Subscriber Service Card

300,000-psi Bolts

Tension and shear bolts rated at 300,000-psi tensile strength are being produced by Standard Pressed Steel Co. The 300,000-psi development is actually a fastening system rather than just a bolt, since SPS has simultaneously developed mating locknuts, load-bearing and preload indicating washers and a high-strength socket wrench. Use of these allied components is essential to insure development in initial tightening of full potential strength of the bolt. SPS is now producing both tension and shear bolt versions in diameter sizes #10 through ⅞ in. and shear bolts in sizes #10 through ⅝ in. A complete fastening system has been developed for both versions.

Circle No. 228 on Subscriber Service Card

Digital Instrument Package

A standard digital instrument package for logging applications, consisting of a V-70 digital voltmeter, a scanner and an 11-channel printer is available from Cubic Corp. The high-speed manual ranging data system will plug into any conventional a-c outlet and readout data at 100 channels per minute. System accuracy has been set at 0.01% plus or minus one digit. Called the S-70,

the package has been designed for applications in environmental test data recording, modular check-out and production check-out, where recorded data is necessary. The portable instrumentation package can also be assigned to rugged field-test projects where logging of digital information is required.

Circle No. 229 on Subscriber Service Card

High-Speed Camera

A 16 mm camera with better resolution, greater capacity, fast film acceleration to regulated velocity and performance reliability is available from Wollensak Optical Co. The unit has a 1200-ft. capacity, darkroom loaded "T" core magazine, and a variable speed

range controlled by a solid-state loop servo device.

The camera has timing markers, electrical inter-locks, ready lights, speed indicators, footage counter and standard 115V a-c, 60 cycle power input. The unit is also supplied in an RFI-protected oscillographic version for high-speed oscilloscopic recording.

Circle No. 230 on Subscriber Service Card

Teletype Rekeyer

Ortronix Inc. has developed a fully transistorized teletype rekeyer offering increased reliability and performance over the vacuum tube equivalent. In addition to reducing size by 90%, the transistorized unit is less expensive and requires less maintenance time but supplies higher power output. The Model #5128 transistorized rekeyer is designed to condition signals necessary to drive #14 or #28 teletypewriters. Outputs of 30ma and 60ma are available for operation to hold or energize the teletypewriters.

Circle No. 231 on Subscriber Service Card

Scintillation Detector

A transistorized, portable, and battery-operated underwater scintillation detector has been designed and produced by Franklin Systems Inc. The instrument measures all beta and gamma radiation in the sea to depths of 1000 feet. Model 60-4 scintillation detector consists of a submersible detector probe, cable, and readout package. The probe contains a 7-in.-diameter plastic scintillation sphere with a nominal 20 mg/cm² waterproof coating which detects the undersea radiation.

Circle No. 232 on Subscriber Service Card

Microminiature Relays

A series of sensitive, 6PDT, microminiature relays for dry circuit to high-level switching is available from Electronics Division of the Iron Fireman Manufacturing Co. Designated the 100N Series, these new relays conform to and exceed the test specifications of MIL-R-5757D, and feature bifurcated contact construction for longer life and greater reliability.

Circle No. 233 on Subscriber Service Card

Grooving Tool

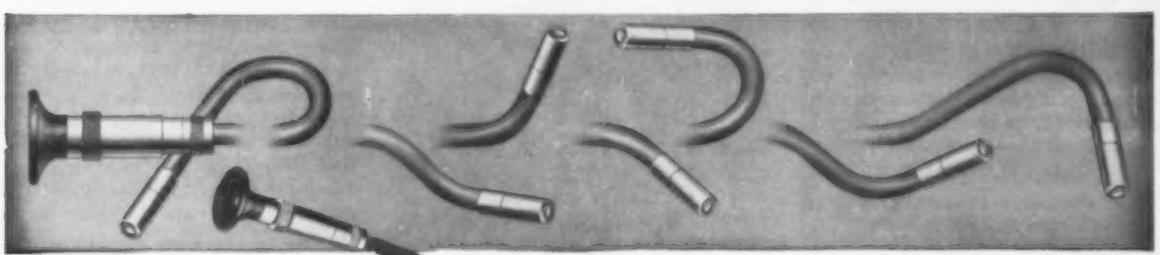
A tool designed specifically to cut accurate grooves for O rings, or similar seals, on the curved surface of a cylinder is available for Avco's Research and Advanced Development Division. The ring groove cutter is a lightweight fixture attachment for a machine tool with a rotating table, such as a lathe. A work piece is placed in the fixture and a cutting tool is set into it to produce the O ring groove.

Circle No. 234 on Subscriber Service Card

IF/Parametric Amplifiers

Airborne Instruments Laboratory Division of Cutler-Hammer, Inc., is marketing a complete line of IF preamplifiers. Standard models are at 30 mc and 60 mc with both narrow-band and wide-band versions available. The low-noise preamplifiers include single-ended, double-ended balanced and unbalanced input configurations.

A low-noise parametric amplifier covering the 2200 to 2300 mc telemetry band is also available. The amplifier is of the one-port variety, with both input and output at the signal frequency. One



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FOR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

Please send details and sketch of your requirements.

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Questions and Answers about the

GLOBAL COMMUNICATIONS CAPABILITIES of RCA

What capabilities? From which subsidiary of RCA?

From RCA Communications, Inc.

Uncommon capabilities for designing and operating **ground communications networks of world-wide scope** needed by contractors, sub-contractors, and government agencies engaged in **space or missile projects.**

RCA Communications also provides facilities for private communications . . . data communications . . . and commercial communications of all kinds — telegraph, telex, radiophoto, and radiotelephone by means of radio and coaxial cable channels. It designs not only completely new systems but also systems incorporating the most efficient and economical arrangement of established facilities.

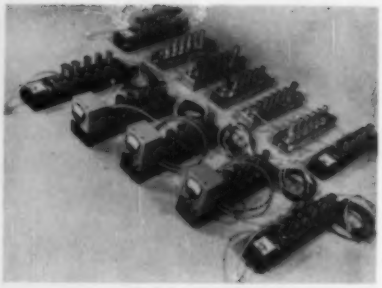
How were these capabilities acquired?

Through 41 years experience in building and operating a world-wide communications system. Today, RCA's integrated telegraph, telex, and radiophoto networks reach more than 100 countries and ships at sea.

In what ways does RCA make its capabilities available?

As contractor or consultant. For more information, write RCA Communications, Inc., Advanced Projects Section, 66 Broad St., New York 4. Tel. Hanover 2-1811, Area Code 212.

RCA® The Most Trusted Name in Communications

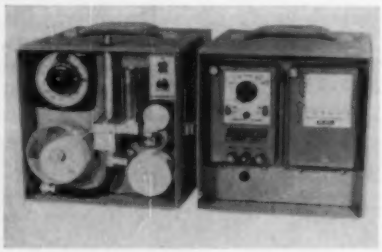


of the major features of this new parametric amplifier is that tuning is not required and a maximum system noise figure of 2.5 db is guaranteed for an 8 db second-stage noise figure.

Circle No. 235 on Subscriber Service Card

Phototape Sampler

A Phototape Sampler which eliminates the manual collection and evaluation of samples of dust from the air is available from Gelman Instrument Co. It is also ideally suited for many gas sampling and determination applications. The sampler automatically collects samples on a paper tape and then

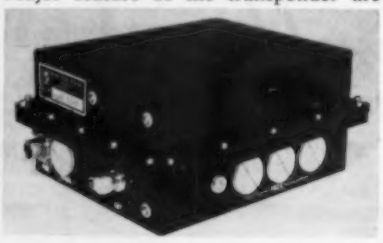


evaluates and permanently records the concentration of dust or gas on a strip chart. Operation is automatic and foolproof. The strip chart is driven by a synchronous motor which accurately relates the time of day at which the sample was taken. In this way the accumulation of errors resulting from the repeated addition of slight inaccuracies in sampling time duration is completely eliminated.

Circle No. 236 on Subscriber Service Card

S-Band Transponder

Aero Geo Astro Corp. has developed an S-Band (2700 to 2950 mc) radar transponder, the AGA S/T-CV. Major feature of the transponder are its crystal video receiver and the fact that it is completely transistorized except for the ceramic triode transmitter tube. These features make the transponder much smaller and lighter than conventional transponders with superheterodyne receivers. The AGA S/T-CV has a receiver sensitivity of −40 dbm over the frequency range and a transmitter output of 3 watts minimum. Higher-power models are available. Input voltage is 28 VDC and power drain is 0.25 amps at a 1000 pps rate.



Circle No. 237 on Subscriber Service Card

Power Supply

A new model of the Amplitude-Regulating Power Supply, Type 1236-B, which provides 1-kc square-wave modulation from an internal generator, is being made by the General Radio Co. Designed for operation with uhf and vhf oscillators, this improved instrument maintains the oscillator output amplitude constant as the frequency is varied. The square-wave modulation feature increases the usefulness of the power supply, since it permits the use of a tuned audio amplifier following the detector, thus achieving high sensitivity with a simplified setup.

Circle No. 238 on Subscriber Service Card

Communications Receiver

An 11-tube Superheterodyne Receiver, Model 850/2, from Marconi Instruments, 600 Kc, completing the range of Eddystone Receivers which now give coverage from 10 Kc to 1000 Mc. 5uV Sensitivity for 15 db to Noise Ratio, variable bandwidth from 400 cps to 6 Kc and greater than 50 dB image rejection are featured in this design.

Provisions are included for CW, AM and SSB reception. This instrument is also valuable for use as an RF Bridge null indicator, RFI detector and for general low-level laboratory measurements.

Circle No. 239 on Subscriber Service Card

Damped Accelerometers

Kearfott Division, General Precision, Inc., is producing the F2401-01A accelerometer, a d-c torquer-restrained device possessing a useful dynamic measuring range of greater than twenty million. The sensitive element consists of a symmetrically located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis. The high degree of symmetry of both force coils and pick-off coils minimizes the errors which might otherwise occur during vibratory inputs.

Circle No. 240 on Subscriber Service Card

Circle No. 9 on Subscriber Service Card

contracts

AIR FORCE

$3,880,000—**Aerojet-General Corp.**, Sacramento, Calif. for production of Stage II *Minuteman* solid propellant rocket motors.

$2,123,330—**Avco Corp.**, Wilmington, Del. for development, fabrication and test of decoys for the *Nike-Zeus* target support program.

$1,688,000—**American Bosch Arma Corp.**, Garden City, N.Y. for production of classified missile guidance sets.

$1,600,000—**United Aircraft Corp., Hamilton Standard Div.**, Windsor Locks, Conn. for research and development on an advanced stellar guidance system.

$1,200,000—**Douglas Aircraft Co.**, Santa Monica, Calif. for production of ground equipment for *Skybolt* missiles.

$1,000,000—**North American Aviation, Rocketdyne Div.** for follow-on procurement of propulsion systems for *Atlas* missiles.

$465,000—**Sylvania Electric Products, Inc.**, a subsidiary of General Telephone & Electronics Corp., Los Altos, Calif. for klystrons and magnetrons.

$300,000—**Solid State Radiations, Inc.**, Los Angeles, Calif. for research and development in nuclear detection.

$106,583—**Delco-Remy Division, General Motors**, for upgrading performance of silver-zinc batteries used in *Minuteman* ICBM.

$104,000—**W. R. Grace & Co.**, New York, N.Y. for the development of manufacturing method for a new type of thermistor.

ARMY

$1,790,959—**Sperry Utah Co. Division, Sperry Rand Corp.**, Salt Lake City, Utah for tactical missile repair parts (3 contracts).

$1,354,103—**Ralph M. Parsons Co.**, Los Angeles, Calif. for development of criteria and definite drawings for *Nike-Zeus* system and revisions to test facilities and standard plans for *Nike-Zeus*.

$371,937—**Raytheon Co.**, Lexington, Mass. for concurrent repair parts, *Hawk* missile systems.

$288,409—**The Martin Co.**, Orlando, Fla. for *Lacrosse* contractor technical services.

$245,000—**M. W. Hills Construction Inc.**, Salina, Kansas for furnishing and installing silo sleeves for blast closures in operational base, missile launch complexes, at Lincoln AFB, Altus AFB and Walker AFB.

$99,481—**Douglas Aircraft Co., Inc.**, Santa Monica, Calif. for procurement of *Nike* replenishment spare parts—fail-safe kit.

$73,300—**Nortronics, a Div. of Northrop Corp.**, Anaheim, Calif. for *Hawk* launchers.

$34,882—**Western Electric Co., Inc.**, New York, N.Y. for procurement of replenishment repair parts, *Nike* missile system.

MISCELLANEOUS

$2,400,000—**Avco Corporation, Lycoming Division**, Stratford, Conn. from Thiokol Chemical Corp. for production of an undisclosed number of rocket motor cases for the *Dyna-Soar* manned space glider program.

$320,000—**Shielding, Inc.**, Riverton, N.J. from General Electric Co. for a manufacturing, controlled environment facility to be installed in G.E.'s Space Technology Center, Valley Forge, Pa.

$320,000—**Lamtex Industries, Inc.**, Farmingdale, N.Y. from Thiokol Chemical Corp. for the development and manufacture of fiberglass-reinforced plastic cases for *Minuteman* ICBM solid propellant rocket engines.

$280,000—**American Electric, Inc.**, Paramount, Calif. from The Boeing Co. for silo closure equipment for the *Minuteman* program.

$250,000—**Space Recovery Systems Div., Itek Corp.**, El Segundo, Calif. from Douglas Aircraft Co. to develop recoverable data capsules for use in suborbital tests of NASA's *Echo* A-12 satellite.

$250,000—**Dorsey Trailers, Inc.**, Elba, Ala., subsidiary of Dorsey Corp., from The Boeing Co. for van bodies to be installed on truck chassis for use at *Minuteman* launching sites.

$248,777—**Yardney Electric Corp.** from the Martin Co. of Denver, Colo. for silver-zinc batteries to be used in the Martin *Titan II* missile.

$200,000—**Microlab, Inc.** from The Boeing Co. for electronic assemblies for *Minuteman* hardened and dispersed silo complexes.

$150,000—**Paul Hardeman, Inc.**, Stanton, Calif. from The Boeing Co. for installation of electronic ground support equipment for the AF *Minuteman*.

General Electric Co. from The Boeing Co. for electric power unit to be used in launch control facilities in *Minuteman* program (amount not disclosed).

Dynamics Corporation of America from the Hughes Aircraft Co. for construction of a FM receiving system that will pick up signals reflected off a passive satellite (no amount disclosed).

Bissett-Berman Corp., from Raytheon, Santa Monica, Calif. for work on *ARPAT* ballistic missile defense.

NASA

$97,350—**The Eagle-Picher Co., Chemical and Metals Div.**, Cincinnati, Ohio for four items of batteries zinc silver oxide.

Electronic Memories, Inc., Los Angeles, Calif. for the preliminary design of a magnetic core memory for use in space probe vehicles (no amount disclosed).

NAVY

$1,500,000—**Sperry Gyroscope Co.**, Syosset, L.I., N.Y. for support and training equipment and services in connection with navigation subsystems for ballistic missile submarines.

$780,000—**B. F. Goodrich Aerospace and Defense Products**, Akron, Ohio, for the manufacture of solid fuel motors for the *Sidewinder* missile.

$493,742—**Ruscon Construction Co.**, Charleston, S.C. for construction of missile assembly control bldg. at the Naval Weapons Annex, U.S. Naval Ammunition Depot, Charleston, S.C.

$487,465—**Servomechanisms, Inc.**, El Segundo, Calif. for true air speed computer components.

$266,000—**B. F. Goodrich's rocket motor operation**, for the production of solid fuel motors for *Loki* atmospheric sounding rocket.

$259,976—**Fred A. Arnold, Inc.**, Los Angeles, Calif. for modifications to missile assembly and range users engineering bldgs., Naval Missile Facility, Point Arguello, Lompoc, Calif.

$218,673—**Technical Appliance Corp.**, Sherburne, N.Y. for development of ten phase rate antennas for installation at U.S. Navy Space Surveillance Station.

$131,800—**The Cardan Co.**, Los Angeles, Calif. for construction of vehicle support bldg., launch complex I, Naval Missile Facility, Point Arguello, Lompoc, Calif.

$85,566—**Quantatron, Inc.**, Santa Monica, Calif. for research and development on a coherent infrared ranging system for missile borne applications.

Boeing openings in Design Reliability Assurance and Design For Maintainability

Expanding space and missile programs at Boeing's Aero-Space Division offer exceptional career opportunities to specialists in design reliability and design for maintainability. Requirements are a BS degree in Engineering, Physics or Mathematics/Statistics, plus one year of experience in Applied Mathematical Statistics and aircraft and/or missile systems equipment, development or analysis.

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BOEING

names in the news

FARNHAM

REXROAT

SCHOENLEIN

JERNIGAN

ALLEN

Leon L. Farnham: Appointed corporate director of advanced engineering of Fairchild Stratos Corp., Hagerstown, Md. He will direct research and development studies into advanced areas of aerospace technology and will initiate and evaluate new concepts leading to future aerospace applications in his newly created corporate post.

Farnham has been associated with General Electric's Missile and Space Vehicle Department where, most recently, he had been manager of design engineering on the *Apollo* spacecraft program; he previously managed the engineering design and integration of all flight vehicles. Prior to his position with General Electric, he was a specialist in design of high-speed aircraft and missile structures, at Chance Vought, and had earlier been with the Martin Co.

Lloyd A. Hart: Named to the new post of vice president and manager of Contract Sales, new department of Forbes and Wagner, Inc., Silver Creek, N.Y. The position entails responsibility for securing military and commercial contracts and subcontracts for custom electronic, electrical, electro-mechanical and mechanical assemblies, and for promoting the company's lines of electronic magnetic components. Hart has held managerial positions with General Electric Co. and General Dynamics Electronics.

William M. Jenkins: Appointed manager of the newly created European Operations for the Information and Control Systems Product Section, General Electric Company's Defense Systems Department. The operation will be headquartered at Wiesbaden, Germany, and staffed by approximately 500 employees who will install, checkout, maintain and support the Air Weapons Control System 412L. Jenkins has been with General Electric since 1949.

L. D. Rexroat: Elected president and chairman of the board of U.S. Science Corporation. He joined the organization in 1960 as vice president of marketing and member of the board of directors. Rexroat, who has had 20 years of management experience in industry and the Air Force, has previously been associated with Sylvania Electric Products, Inc., Haller Raymond and Brown Inc., and the Philco Corp.

John L. Sigrist: Promoted to director of programs in Douglas Aircraft Company's Missile and Space Systems Division. Sigrist, who joined the company in 1939, will be responsible for program management of the *Nike-Zeus, Saturn S-IV, Thor* and *Genie* programs, as well as all new programs assigned to the Missile and Space Systems Division.

William T. Golden: Elected chairman of the board of trustees of System Development Corp., Santa Monica, Calif. Golden, a board member since 1957, succeeds **Fran Collbohm.** He is a director of many national corporations and a well-known industrial and financial management expert. He has served on many government financial and procurement projects and, as a special consultant to the White House, reviewed the organization of military-scientific activities incident to the Korean War. Golden also served with the Hoover Commision and was special assistant to the commissioner of the Atomic Energy Commission from 1946 to 1950 and acted as consultant to that agency until 1958.

Raymond W. Meyer: Named director of quality assurance for Eitel-McCullough, Inc. In this newly created position, he will develop corporate quality assurance policies and coordinate the quality control programs of the company's five operating divisions. Prior to joining the firm, he was associated with Lockheed Electronics, the Burroughs Corporation, Hoffman Radio Corporation and Radio Corporation of America.

Earl L. Schoenlein: Named vice president of sales of Thompson Industries division of Space Equipment Corp., Los Angeles. Prior to joining the company, he had been associated with Houston-Fearless Corp., and North American Aviation, Inc.

John M. Lambert: Appointed manager of Advanced Systems in the Systems Division of Avien, Inc. In his new post he will be responsible for development of advanced radar and communications systems. Lambert was previously project engineer with the Defense Systems Department of General Electric Co.

E. D. Jernigan: Appointed to the new position of manager of aerospace programs at Industrial Nucleonics Corp., Columbus, Ohio. In this assignment, he will be responsible for the direction of all industrial nucleonics research and development activities pertaining to the U.S. Air Force and NASA. Prior to joining the company Jernigan was with Motorola, Inc.

Robert D. Schmidt: Appointed vice president-marketing, Electronic Memories, Inc. Before joining the company, he was manager of the Components Division of Ampex Computer Products Company, and has held a variety of executive positions with Telemeter Magnetics, Inc., Remington Rand and the U.S. Navy.

Dr. Murray I. Disman: Named manager of microwave tube development, Eitel-McCullough, Inc. He will direct the development of Eimac reflex Klystrons, traveling-wave tubes, voltage-tunable magnetrons and low-power amplifier klystrons. Before joining the company in 1959 Disman was a research associate on high-power traveling-wave tubes at Stanford Electronics Laboratory, Stanford University, Calif.

Virginia Allen: Appointed controller at E. V. Roberts & Associates, Inc., Los Angeles. Miss Allen, with the firm for over seven years, will supervise financial operations of the corporation. She was formerly associated with Liberty Manufacturing and Arc Advertising, both in California.

Gerald S. Linseth: Appointed Sales Engineer of Clevite Transistor, Division of Clevite Corp., Los Angeles office. Linseth was formerly with Hughes Semiconductor Division.

William J. O'Sullivan, Jr.: Scientist at the NASA Langley Research Center, Va., has received a $5000 award from the agency. The award was given for his

contribution to space science and technology in conceiving an inflatable space vehicle invention and initiating and directing its successful development. O'Sullivan has been a research scientist at the Langley Center since 1938 and at present is head of the Space Vehicle Group.

Dr. James A. Bittles: Joined Electro-Optical Systems, Inc., as a senior scientist in the Quantum Physics department. His duties will entail a broad research program in materials for masers, lasers, and related areas. Before joining the company, Bittles was a research associate at the University of Southern California; still earlier, he was a research chemist at E. I. duPont de Nemours, Wilmington, Del.

Dr. Peter M. Kelly: Named head of the instrumentation and electronics department at Astropower, Inc., Costa Mesa, Calif. The recently established office is conducting research and development activities in such areas as information processing, advanced instrumentation and spacecraft electronics. Previously, Kelly had been with the Aeronutronic division of Ford Motor Co. and Hughes Aircraft Co.

Joseph A. Ricca: Joined Ford Motor Company's Aeronutronic Division, Newport Beach, Calif., as manager of planning for electronics operations; **Charles H. Sword** has joined as manager of operations staff for electronics operations. Ricca, a former management consultant, has had a number of years experience in the electronic field with Hubbard and Co., DuMont, Norden-Ketay Corp., and General Electric. Sword will be responsible for administrative, contract-administration, and market-planning activities. He has been associated with North American Aviation, Computers and Data Systems, and with Autonetics.

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—when and where—

DECEMBER

National Aerospace Support and Operations Meeting, sponsored by Institute of the Aerospace Sciences, San Juan Hotel, Orlando, Fla., Dec. 4-6.

19th Annual Electric Furnace Conference, the Metallurgical Society of AIME, Penn-Sheraton Hotel, Pittsburgh, Dec. 6-8.

Eastern Joint Computer Conference, sponsored by IRE-PGEC, AIEE and ACM, Sheraton Park Hotel, Washington, D.C., Dec. 12-14.

Annual Meeting, American Association for Advancement of Science, Denver, Dec. 26-31.

Annual Meeting, American Statistical Association, Roosevelt Hotel, New York City, Dec. 27-30.

JANUARY

8th National Symposium on Reliability and Quality Control, Statler-Hilton Hotel, Washington, D.C., Jan. 9-11.

National Plant Engineering and Maintenance Show and Conference, Convention Hall, Philadelphia, Jan. 22-25.

Solid Propellant Rocket Conference, ARS, Baylor University, Waco, Tex., Jan. 24-25.

FEBRUARY

Western Electronic Week and Pacific Electronic Trade Show, Las Vegas and Los Angeles, Feb. 3-11.

Winter Convention on Military Electronics, IRE, Ambassador Hotel, Los Angeles, Feb. 7-9.

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editorial . . .

Inside Story of Apollo

THE U. S. ENTRY in the race for the moon is off to an excellent start with the selection of North American Aviation as prime contractor on the *Apollo* spacecraft.

The California firm has won the toughest and most important competition since the birth of the young missile/space industry. From a company standpoint, the losers must grieve and we grieve with them. But certainly they will agree that the award has gone to an able competitor. The national interest has been well served.

How did North American win? That soul-searching question now is being asked in Philadelphia, Baltimore, St. Louis and elsewhere. We give you here the inside story of just how North American walked off with the award.

First, let us deal with the most obvious answer—politics. On this page, we reported last spring a very real fear of almost every missile/space firm in California: that the new Administration might take political vengeance on the home state of former Vice President Richard M. Nixon. North American was one of the firms most concerned, for apparent reasons. This was not a worry taken lightly. Top executives of California firms, both Democrats and Republicans, met privately to discuss the problem.

The award to North American has laid that ghost to rest. The Administration has demonstrated in the most effective way possible that it places national welfare ahead of its political welfare.

If not politics, what then? Was the contract let to a firm hungry for business? North American stands in the No. 1 position on the list of NASA contractors for Fiscal '61, its $75 million total one and a half times that of the next company on the list. It is in third position on the list of Department of Defense contractors, with over $964 million in military contracts. Company officials feared this very success might work against NAA in the *Apollo* competition. Again, in placing the contract in defiance of the conventional spread-the-business pattern, the Administration exhibited a welcome recognition of the importance of this project.

With both politics and affluence working against it, North American's secret of success in the *Apollo* competition lies elsewhere. It can be traced back to 1946, when NAA entered the guided missile field with a research and study contract. Out of this early work came the Air Force's SM-64 *Navaho*, a long-range air-breathing strategic missile. A major effort, the *Navaho* program was cancelled when the feasibility of an intercontinental ballistic missile became apparent.

Capable management even then was laying the foundation responsible for today's *Apollo* success. NAA President Lee Atwood and Board Chairman J. H. "Dutch" Kindelberger, among the first to sense what was ahead for the aircraft industry, diversified North American into missiles, nucleonics, electronics and rocket propulsion, building a strong technical competence in each of the new fields.

BUT THE SIGNIFICANT date in the inside story of the *Apollo* victory is 1941—20 years ago. That was the year a young aeronautical engineer with degrees from Northwestern and Cal Tech joined North American in the aerodynamics group. His name was Harrison A. Storms, Jr. He became group leader in 1947 and was named assistant chief technical engineer in 1951. By 1953, he was chief technical engineer. Three years later he was promoted to manager, research and development, and the following year he became chief engineer of the Los Angeles Division. In February, 1960, Storms was named a vice president of the Los Angeles Division. His accomplishments included work on the B-25, P-51, T-6, T-28, B-45, F-86, F-100, F-107, F-108, T-39, B-70 and the space probing *X-15*.

Then in December, 1960—another significant date in the *Apollo* story—North American took a major gamble. Company management looked at the prospects of the B-70 and the prospects of the space program. Storms moved out of the Los Angeles Division to become president of the Missile Division at Downey, Calif., now the Space and Information Systems Division.

With him, Storms took a major portion of the *X-15* design team, including pilot Scott Crossfield. At Downey, they put together their *Apollo* proposal and went after the contract. Last week, they got it.

Several weeks ago, we spent an evening with Harrison Storms in New York. Over dinner and later over the wailing of a blues singer in a Village jazz joint, he talked *Apollo, Apollo, Apollo*. Stormy desperately wanted that contract, not just for North American, but because he felt his *X-15* team could do the best job on it for the nation. He's that kind of man. We're glad he won.

So the inside story of North American's *Apollo* success is an old one—capable men on the technical team and capable men in management. It's a hard combination to beat—particularly when sparked by a burning desire to build the best and backed by a long record of doing exactly that.

William J. Coughlin

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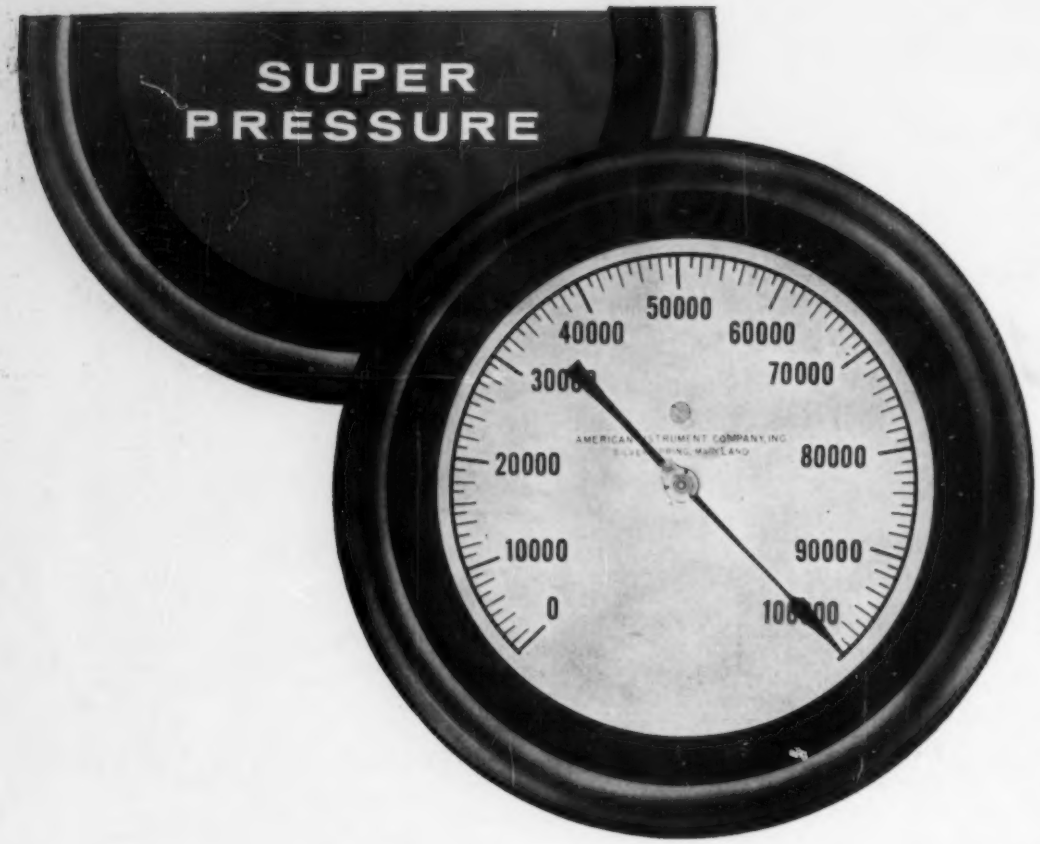

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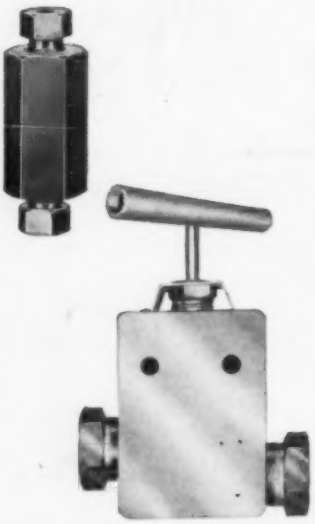

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